INTRODUCTORY ESSAY

TO THE

FLORA INDICA:

INCLUDING

PRELIMINARY OBSERVATIONS ON THE STUDY OF INDIAN BOTANY;
A SUMMARY OF THE LABOURS OF INDIAN BOTANISTS;
A SKETCH OF THE METEOROLOGY OF INDIA;
OUTLINES OF THE PHYSICAL GEOGRAPHY AND BOTANY OF THE PROVINCES OF INDIA.

With Two Maps.

BY

J. D. HOOKER, M.D., R.N., F.R.S.,

AND

THOMAS THOMSON, M.D., F.L.S.,

SURGEON, H.E.I.C.S.

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TO

SIR W. J. HOOKER, K.H., F.R.S.,

LL.D., D.C.L. OXON., ETC. ETC. ETC.,

TO WHOM THE AUTHORS ARE INDEBTED FOR THEIR EARLIEST

INSTRUCTION IN THE SCIENCE OF BOTANY,

FOR THAT ASSISTANCE AND ENCOURAGEMENT WHICH ALONE HAS

ENABLED THEM TO PURSUE IT IN AFTER LIFE,

AND IN WHOSE UNRIVALLED HERBARIUM AND LIBRARY

THE 'FLORA INDICA' HAS BEEN COMMENCED,

This Work is Dedicated

BY HIS AFFECTIONATE SON, AND PUPIL,

JOSEPH D. HOOKER

AND

THOMAS THOMSON.

ROYAL GARDENS, KEW,
February, 1855.

PREFACE.

THE object, scope, and design of this Work, together with the motives that induced us to commence it, are all detailed in the Introductory Essay.

It will be seen that we anticipated considerable difficulty in our proposed attempt to establish the genera and species of the 'Flora Indica' on a sound and philosophical basis, and to unravel their synonymy. The result has proved that we underrated the difficulties of the task, for the number of plants described is very much smaller than we hoped to have accomplished, and in many of the genera the species are not satisfactorily limited. This has arisen from many causes, to two of the most important of which, as suggestive of improvements that may be introduced into botanical science, we shall briefly allude.

In the first place, a critical study of the vast number of well-selected specimens that we possess of most of the plants, has enlarged those already extended views of the variability of species which we have professed in our Introductory Essay. In every case, the more specimens we examined, and especially if taken from different individuals, the greater the difficulty in framing diagnoses. This has shaken our confidence in the sufficiency of the descriptions we have drawn up from few specimens; and it proves that the characters of exotic plants,

in systematic works, being unavoidably those of *individuals*, and not of *species*, have been far too much relied on as affording means of identification.

The other great obstacle has been the immense number of works, and especially of periodicals, we have had to consult: 120 authors' names are attached to the 430 species described, and the completion of the 'Flora Indica' will require a reference to upwards of 1000 volumes. We would now therefore call the attention of our fellow-botanists to the fact, that the time is rapidly approaching, when the difficulty of obtaining access to the necessary periodicals must render the effectual study of botany impossible; and that the practice of naturalists sending their several papers to different periodicals, and above all to local ones, or to such as embrace many branches of science, is one of the greatest obstacles to the study of natural history in the present day. We have found it impossible to obtain access to several journals of local or of ephemeral interest, and it would be well if isolated naturalists paused before they sought to establish such, or to send their contributions where they must be inevitably overlooked.

After a careful review of the state of botanical literature, in this country at any rate, we have no hesitation in saying that the Transactions of well-established Associations for the furtherance of natural science, diffuse most effectually the labours of naturalists. This is because these societies are supported by persons whose interest it is to disseminate their publications at the smallest possible delay and cost; and, what is of great importance, all papers communicated are subjected to a system of supervision before publication, which ensures their being worthy of it.

We need not say, that while urging the propriety of centralization within reasonable limits, we are far from wishing to see the natural and physical sciences entirely separated. In

a large scientific community there is always a Society established for the furtherance of such researches as have a very wide-spread interest, not confined to the branch they especially illustrate, nor even to the class of sciences under which they rank: but researches of such importance are necessarily rare, and the Transactions in which they are embodied are universally accessible.

It is the intention of the Authors to continue the 'Flora Indica,' one of them in the Hookerian Herbarium, the other at the Calcutta Botanic Gardens. The propriety, however, of pursuing the attempt to complete the history, etc., of each Indian genus and species, is, in the present state of science, very doubtful. Considering how little is accurately known of the outlines of Indian Botany, and how extensive our materials are, it may be better to ensure accuracy in the most important identifications only, and to omit quoting such works as are not worth referring to. In this we shall be guided by the opinions of those botanists who may honour us by consulting our labours critically.

CONTENTS OF INTRODUCTORY ESSAY.

1. *Systematice* plantas suas disponit verus Botanicus;
   Nec absque ordine easdem enumerat.
2. *Frutificationis* principium in theoretica dispositione agnoscit;
   Nec dispositionem secundum Herbam immutat.
3. *Genera* naturalia assumit;
   Nec erronea ob speciei notam aberrantem conficit.
4. *Species* distinctas tradit;
   Nec e Varietatibus falsas fingit.
5. *Varietates* ad species reducit;
   Nec eas pari passu cum speciebus obambulare finit.
6. *Synonyma* præstantissima indagat et seligit;
   Nec acquiescit in quacunque obvia nomenclatura.
7. *Differentias* characteristicas inquirit;
   Nec inania nomina specifica præponit veris.
8. *Plantas* vagas ad Genera amandare studet;
   Nec rariores obvias fugitivis oculis adspicit.
9. *Descriptiones* complectentes differentias essentiales compendiose sistit;
   Nec naturalissimam structuram oratorio sermone ebuccinat.
10. *Minimas* partes attente scrutatur;
    Nec ea quæ maxime illustrant, flocci facit.
11. *Observationibus* ubique plantas illustrat;
    Nec in vago nomine acquiescit.
12. *Oculis* propriis quæ singularia sunt observat;
    Nec sua solum, ex Auctoribus, compilat.

LINNÆUS, *Philosophia Botanica.*

INTRODUCTORY ESSAY.

IN the following pages it is our intention not only to explain the objects of the Flora Indica, and our reasons for undertaking it, but also to dwell upon a considerable number of topics having a direct bearing upon the study of Systematic Botany, and upon the correct appreciation of which must depend the progress which the student may make in this department of science. As however the principal aim of our labours is to further the study of Botany in India, we shall confine ourselves as much as possible to those points which it is more particularly essential for the Indian botanist to understand well, and we shall illustrate them by a reference to the plants of that country. The chief subjects treated of in this Essay will therefore be:—

1. The object, scope, and design of the Flora Indica, and our motives for undertaking it.

2. General considerations connected with the study of systematic and descriptive botany.

3. The influence of variation, the origin of species, specific centres, hybridization, and geographical distribution, on the views taken by ourselves of species, and of the right manner in which they should be treated, and in which their affinities should be developed. We consider these theoretical points to be inseparable from a philosophical study of plants, and we believe it to be essential that systematic authors should

explain the principles by which they are guided in the execution of similar works to this.

4. An historical summary of the labours of our predecessors in Indian botany, whether as authors or collectors, and some account of the materials at our disposal.

5. A sketch of the meteorology and climate of India, the excessive complexity of whose seasons offers the most formidable obstacle to the student's appreciation of the prominent features of its vegetation.

6. An attempt to divide the area embraced in the Flora Indica into physico-geographical or geographico-botanical districts. This is intended to serve the double purpose of giving a slight sketch of the physical characters and vegetation of these provinces, and of adopting such a carefully-selected system of nomenclature, as shall be available for assigning intelligible localities to the species in the body of the Flora, and such as may be easily committed to memory, or found with little trouble on any map. We have long deplored the defective geographical nomenclature adopted in almost every work treating of the Natural History of India, and the fact that "E. Ind." or "Ind. Or." is considered in most cases sufficiently definite information as to the native place of any production found between Ceylon and Tibet, or Cabul and Singapur; and we hope that the present attempt to remedy so important a defect will be received with indulgence.

I. *Object, scope, and design of the Flora Indica.*

Our object, in the work here commenced, is to present a systematic account of the vegetable productions of British India, arranged according to natural principles, and based upon a careful examination of all the materials within our reach. Besides the descriptions of the Orders, Genera, and Species, all matters of importance connected with anatomical, structural, morphological, and physiological points, will, wherever it is practicable, be treated of, and in other cases pointed out as

subjects worthy of future attention. Geographical distribution, and the effect of climate, soil, and exposure, have been made the objects of our special study, and will in all cases be particularly noted. With regard to economic botany, it is obviously impossible to do more than briefly enumerate, under their respective species, the various products which have been used in the arts: for detailed accounts of their value, we must refer our readers to the many excellent works on those subjects, which have been published by Indian botanists.

Our work is intended to facilitate the progress of economists, by supplying their great desideratum, a critical description of the plants which yield the products they seek. We have had a considerable experience both in medical and economic botany, and we announce boldly our conviction, that, so far as India is concerned, these departments are at a stand-still, for want of an accurate scientific guide to the flora of that country. Hundreds of valuable products are quite unknown to science, while of most of the others the plants are known only to the professed botanist. The mass must indeed always remain so: just as the refinements of the laboratory and the calculations of the mathematician must ever be mysteries to the majority of manufacturers and navigators, whose operations are based on the sciences in question. It is a mistake to suppose that it can be otherwise; or that those who are engaged in forwarding a science so extensive and abstruse as philosophical botany, can command the time to become so familiar with the details of the commercial value of vegetable products, as to be safe referees on these subjects. On the other hand, it is equally a mistake to suppose that those who devote themselves to the collection of economic products, can possess the experience and botanical knowledge necessary to render their identifications of tropical plants trustworthy in the eyes of men of science*. It is therefore as a strictly

* For proof of this we have only to refer to the pages of any book on medical or economic botany; and to the fact, first indicated in these pages, that the celebrated Bikh Poison, about which so much has been written, is produced

scientific work that we offer this commencement of the Flora Indica to the public; but though the advancement of abstract science is indeed its primary object, yet as we yield to none in our estimate of the value of economic botany, we confidently trust that, as pioneers in this department also, our labours will be found of material service.

On this account we need scarcely offer an apology for our partial use of Latin, which is necessary, as well for economy of space, as because we are labouring for the benefit of Continental botanists as well as English ones, and because we write under a sense of the obligation the former have rendered us, by having published in Latin (instead of French or German, or still less familiar languages) the many valuable memoirs on economic and scientific Indian botany, which we owe to their exertions. When the flora of India is established on a scientific foundation, it will be desirable that a compendious English version of such a work as ours should be provided for the use of those who do not pursue science for its own sake, but yet are desirous of availing themselves of its results: at present such an undertaking would be premature.

Had it been possible to take up the economic plants of British India by themselves, and to present a history of them to the English reader, we should at once have devoted ourselves to the task, with the certainty of obtaining an amount of encouragement which a so-called paying work is sure to command, but which one of a more scientific nature is not thought worthy of receiving. We should however only be deceiving the public, were we to propose a scheme which, in the present deplorably backward state of scientific Indian botany on the one hand, and the confusion of Indian economic botany on the other, is literally impracticable. Dr. Royle's great work, published twenty years ago, is the only one on Indian plants that attempts to combine practical with scientific botany; but five volumes of its size would not bring the

in the Himalaya by the common *Aconitum Napellus* of Europe and North America, as well as by other species of the genus.

subject there treated of up to the present state of our knowledge: the difficulties have increased fourfold, from scientific botany not having advanced *pari passu* with the economic branch; and so long as the plants themselves remain undescribed, it is obviously impossible to recognize what are useful, or so to define them that they shall be known by characters that contrast with those of the useless. Our principal aim however being purely botanical, the most insignificant and useless weed is as much the object of our attention as the Teak, Sal, and Tea: in the vegetable kingdom, and in the great scheme of nature, all have equal claims on our notice, and no one can predicate of any, its uselessness in an economic point of view.

Every one who has studied Indian plants, whether for economic purposes or for those of abstract science, must have felt the want of a general work which should include the labours of all Indian botanists, to be a very serious inconvenience. Our own experience in India has convinced us of this; for we found it impossible to determine the names of many of the most ordinary, and, in an economic point of view, often most valuable forms; and every day's additional experience in the preparation of this volume has served to show more and more clearly, that whilst such a work is wanting satisfactory progress is impossible. At present the student has to search in general systematic works, for the descriptions of species; and as all of these are imperfect, a multitude of scattered papers must be consulted for the additions which have from time to time been made. These too have unfortunately so often been published without reference to preceding works of a similar nature, that the same plant has been described as new by many successive botanists, ignorant or neglectful of the labours of their predecessors.

A general flora of India must comprise a careful study of all previously published materials, so as to blend them into an harmonious whole, and to establish Indian botany on a secure basis of observation and accurate description. Such a task is,

however, the labour of a lifetime, and although we have undertaken its commencement, we cannot hope to bring it to a conclusion; our progress in it must depend entirely upon circumstances at present beyond our control; but we have no doubt that when we are compelled to abandon the undertaking, the necessity for the completion of such a work will induce some one to follow in our steps, and to lend a helping hand to the compilation of a further portion of so indispensable an aid to botanical research.

We should however be wrong, were we to convey the impression that this arduous undertaking has wholly originated with ourselves: on the contrary, the conviction has for some years been general among botanists, that the collections accumulated in this country were so ample, that the time had fully come for the preparation and publication of a Flora Indica; and when it was known that we had returned from India with large and important materials, we were invited by all the most illustrious names in the science to combine a revision of the labours of our predecessors with the publication of our own discoveries. Many of our friends considered that for such an undertaking we possessed greater advantages and facilities than had ever before been available to any botanist. Our collections were most extensive, having been formed over a very wide extent of country, with a knowledge of the great variability of species, of the chief forms of which we were desirous of making our specimens illustrative; they were moreover accompanied by an extensive series of drawings and dissections from the life, and by voluminous notes, indicative of distribution, habit, structure, etc. It was known that we intended to distribute our plants, which ought not to be done without a careful examination, for the purpose of determining their names. During this examination much of the most laborious part of the preparation of a flora must necessarily be undergone; and we were urged to put our results on record for the benefit of science. Nor must we omit, in the enumeration of the advantages we enjoyed, a free access

to the rich herbarium and library of Sir William Hooker, and its vicinity to a metropolis containing other collections (especially the Wallichian Herbarium) indispensable to an Indian botanist.

Under a combination of so many favourable circumstances, we felt it our duty to undertake the task proposed to us. Not, however, having at our command the necessary funds, the subject was brought before the British Association at the meeting of 1851, and being most favourably received by its members, the Directors of the East India Company were strongly memorialized on behalf of an undertaking in which it was expected that they would feel the deepest interest. In reply to this recommendation, the Court declined promoting the object, but expressed a willingness to take its merits into consideration on its completion. The President of the British Association, in communicating to us this answer, at the same time intimated to us the hopes of his colleagues that we should at least commence the work. This we did, but, we must confess, with a feeling of discouragement, for the unfavourable answer of the Court materially retarded our progress, our private resources not being sufficient to provide such assistance as would have relieved us from the mechanical labours of arranging, distributing, and writing tickets, which have in consequence hitherto occupied more than three-fourths of our time. The difficulty of the task has also far exceeded our anticipations, as we were not prepared for so large a proportion of Indian plants proving identical with those of other parts of the world. This has obliged us, in every large genus, to have recourse to a critical study of the European, Siberian, Chinese, and Japanese floras, which has elucidated results totally unexpected by ourselves and fellow-botanists, and at the same time of extraordinary interest and importance to the science of Botanical Geography.

As we are anxious to render each portion of the work as complete in itself as possible, and are desirous of enlisting in the cause such of our fellow-botanists as may be willing to

work up those Natural Orders with which they are most familiar, the Flora Indica, when completed, will probably consist of a series of monographs. In the commencement now offered to the public, we have arranged the principal Natural Orders in the mode of sequence usually adopted in systematic works, altering the places of a few of the smaller ones, whose botanical affinities we conceive to have been misunderstood.

We consider it important that the Flora Indica should embrace as wide an area as possible, as we are firmly convinced that no species can be properly defined, until it has been examined in all the variations induced by those differences in climate, locality, and soil, which an extensive area alone affords. As also the flora of an area cannot be worked out without a knowledge of the botany of the countries surrounding it (with which it has many plants in common), it follows that the greater the area embraced, the more fully will it illustrate the habits, forms, and variations, of the species comprised within it. For this reason we have extended the limits of our Flora from Persia to the Chinese dominions.

II. *General considerations connected with the study of Systematic Botany.*

It may seem almost chimerical to look forward to a time when all the species of the vegetable world shall have been classified upon philosophical principles, and accurately defined; and it must be confessed that the present state of descriptive botany does not hold out much prospect of the realization of so very desirable an object. This, we think, is in a great measure due, not to any want of students willing and anxious to take up the subject, but rather to a gradually increasing misapprehension of the true aim and paramount importance of systematic botany, and of the proper mode of pursuing the study of the laws that govern the affinities of plants. We are therefore desirous, at the outset of a work which is devoted to these subjects, of explaining our views on

them; and as we trust that our work will fall into the hands of many beginners who are anxious to devote themselves usefully to the furtherance of botanical science, but who have not an opportunity of acquiring in any other way its fundamental principles, we shall make no excuse for dwelling at some length on the subject. We are also anxious to refute the too common opinion (which has been productive of much injury to the progress of botany) that the study of system presents no difficulties, and that descriptive botany may be undertaken by any one who has acquired a tolerable familiarity with the use of terms.

There can be no doubt that any observant person may readily acquire such a knowledge of external characters, as will in a short time enable him to refer a considerable number of plants to their natural orders; though even for this first step more knowledge of principles is required, than to make an equal advance in the animal kingdom: but to go beyond this, —to develop the principles of classification, to refer new and obscure forms to their proper places in the system, to define natural groups and even species on philosophical grounds, and to express their relations by characters of real value and with a proper degree of precision, demand a knowledge of morphology, anatomy, and often of physiology, which must be completely at command, so as to be brought to bear, when necessary, upon each individual organ of every species in the group under consideration. To follow the laws that regulate the growth of all parts of the plant, especially the structure of stems, the functions of leaves, the development and arrest of floral organs, and the form, position, and minute anatomy of the pollen and ovule, and to trace the whole progress of the ovule and its integuments to their perfect state in the seed, ought all to be familiar processes to the systematic botanist who proceeds upon safe principles; but no progress can be made by him who confines his attention chiefly to the modifications of these organs in individual plants or natural orders.

To many all this may appear self-evident, and we should

fear to be censured for stating truisms, did not the annals of natural science present too many instances of the recklessness with which genera, orders, and even so-called natural systems, have been instituted by tyros without the smallest practical acquaintance with structure and affinities. We do not refer merely to the vagaries of a Rafinesque, a Bowditch, or a Blanco, though a botanist so eminent as Endlicher has thought it necessary to encumber his pages with characters of genera which must remain for ever enigmatical, unless some happy chance should make us acquainted with the specimens of the authors; we have in view more well-meaning persons, who have the progress of science at heart, but who, by defective definitions and erroneous classification, crowd our books with imperfectly defined genera and with groups and subdivisions of no practical value. A knowledge of the relative importance of characters can only be acquired by long study; and without a due appreciation of their value, no natural group can be defined. Hence many of the new genera which are daily added to our lists rest upon trivial characters, and have no equality with those already in existence. A proneness to imitation leads to a gradual increase in their numbers, without a corresponding increase of sectional groups. Indeed, even when the sectional groups are well defined, and the genera in themselves natural, a too great increase in the number of genera is detrimental, by keeping out of view those higher divisions which are of greater importance. The modern system of elevating every minor group, however trifling the characters by which it is distinguished, to the rank of a genus, evinces, we think, a want of appreciation of the true value of classification. The genus is the group which, in consequence of our system of nomenclature, is kept most prominently before the mind, and which has therefore most importance attached to it*.

* We may make our meaning more clear by a few examples. The genus *Ficus* is surely more natural than the subgenera *Pogonotrophe*, *Covellia*, *Urostigma*, into which it has been subdivided. So with the genera *Anemone*, *Hedyotis*, *Erica*, *Andromeda*, and others which have been split into many by modern botanists. Mr. Brown has, in all his works, laboured to keep this

The rashness of some botanists is productive of still more detrimental effects to the science in the case of species; for though a beginner may pause before venturing to institute a genus, it rarely enters into his head to hesitate before proposing a new species. Hence the difficulty of determining synonymy is now the greatest obstacle to the progress of systematic botany; and this incubus unfortunately increases from day to day, threatening at no very distant period so to encumber the science, that a violent effort will be necessary on the part of those who have its interests at heart, to relieve it of a load which materially retards its advancement. The number of species described is now so very great, and the descriptions are scattered through such a multitude of books, that even after long research it is difficult to avoid overlooking much that is already known; and when botanists with limited libraries and herbaria institute new species, it is almost certain that the latter will be found to have been already characterized. To such an extent is this carried, that we could indicate several works, in which one half and even more of the species are proposed in ignorance of the labours of other botanists. Indian Botany unfortunately, far from forming an honourable exception in this particular, presents a perfect chaos of new names for well-known plants, and inaccurate or incomplete descriptions of new ones.

It must be remembered too that the Linnean canon, by which twelve words were allowed for a specific character, is now becoming quite inadequate to the requirements of the science; and that the brief descriptions, which are now so generally substituted for definitions, unless prepared with the greatest skill, as well as care, and after an inspection of very numerous specimens, seldom express accurately the essential characters of a plant. It is indeed becoming more and more evident, that in the great majority of instances no definition is sufficient to enable inexperienced botanists to determine

important principle in view, and to impress it upon others; he has, however, failed to check the prevalent tendency to the multiplication of genera.

with accuracy the species of a plant, even when the whole genus is well known; much more is this the case in genera, many of whose species are yet undiscovered; and most of all, in those where the forms, though sufficiently well known, are liable to much variation. In the last case their determination becomes a special study; and when attempted without access to authentic specimens, leads to inextricable confusion, and its evil effects are not confined to specific botany, but extend to all departments.

The pages of our Indian Flora will supply numerous illustrations of these remarks, and we would direct the attention of those commencing the study to the lesson to be derived from these instructive errors; for where the first botanists of the day have failed, beginners cannot be expected to succeed. It cannot be too strongly impressed upon all students of botany, that it is only after much preliminary study, and with the aids of a complete library, and an herbarium containing authentic specimens of a very large proportion of known species, that descriptive botany can be effectively carried out; and it would be well for science if this were fully understood and acted upon.

The prevailing tendency on the part of students of all branches of natural history, to exaggerate the number of species, and to separate accidental forms by trifling characters, is, we think, clearly traceable to the want of early training in accurate observation, and of proper instruction in the objects and aim of natural science. Students are not taught to systematize on broad grounds and sound principles, though this is one of the most difficult processes, requiring great judgment and caution; or, what is worse, they are led by the example if not by the precepts of their teachers, to regard generic and specific distinctions as things of little importance, to be fixed by arbitrary characters, or according to accidental circumstances. As a consequence, the study of systematic botany is gradually taking a lower and lower place in our schools; and, being abandoned by many of those who are

best qualified to do it justice, it falls into the hands of a class of naturalists, whose ideas seldom rise above species, and who, by what has well been called *hair-splitting*, tend to bring the study of these into disrepute.

It will generally be found that botanists who confine their attention to the vegetation of a circumscribed area, take a much more contracted view of the limits of species, than those who extend their investigations over the whole surface of the globe. This is partly, no doubt, owing to the force of bad example; and partly to the fact that the student who takes up the study of the flora of his native country, finds that the species are all tolerably well known, and that no novelty is to be discovered. There is therefore a natural tendency to make use of trifling differences, from the scope which they afford for minute observation and critical disquisition; whilst the more close comparison of the few species which come under his investigation, leads the local botanist to attach undue importance to differences which the experienced observer knows may be safely attributed to local circumstances. To this tendency there can be no limit, when the philosophy of system is not understood; the distinctions which appeared trifling to botanists a quarter of a century ago, are at the present day so magnified by this class of observers, that they constantly discover novelties in regions which have been thoroughly well explored; considering as such, forms with which our predecessors were well acquainted, and which they rightly regarded as varieties*.

Another result of the depreciated state of systematic botany is, that intelligent students, being repelled by the puerilities which they everywhere encounter, and which impede their progress, turn their attention to physiology before they have acquired even the rudiments of classification, or an elementary practical acquaintance with the characters of the na-

* Many of the species which have been revived in modern times, were indicated by Haller, Ray, Tournefort, and other ancient botanists, but were reduced to the rank of varieties, when the science was reformed by Linnæus.

tural orders of plants. Unfortunately, in botany, as in every other branch of natural science, no progress can be made in the study of the vital phenomena except the observer have a previous accurate acquaintance with the various modifications under which the individual organs of plants appear in the different natural orders, and such an appreciation of the comparative value, structural and morphological, of these modifications, as can only be obtained by a careful study of the affinities of their genera and species. Ignorance of these general laws leads to misinterpretation of the phenomena investigated by the physiologist, and to that confusion of ideas which is so conspicuous in the writings of some of the astute physiological observers of the day.

The modern system of botanical instruction attempts far too much in a very limited space of time, and sends the student forth so insufficiently grounded in any branch of the science, that he is unprepared for the difficulties which he encounters, let his desire to progress be ever so great. The history of botanical discovery, and the philosophy of its advance, form instructive chapters for the student in any department of natural science. In Professor Whewell's 'History of the Inductive Sciences,' the subject is ably sketched for the information of the general reader; and it is there shown that the most important contributions to the progress of the science have been purely physiological questions, investigated with consummate judgment by our most eminent systematists. We owe to Linnæus the establishment of the doctrine of the sexuality of plants; and we find by the writings of the same great naturalist, that besides foreseeing many physiological discoveries, he preceded Goethe in the discovery of morphology, a doctrine which, more than any other, has tended to advance scientific botany. A third great discovery, that of the nature of the ovule, and the relation of the pollen-tube to the ovary, received its principal illustration at the hands of Brown, our chief systematist, and of Brongniart, also a practised botanist.

It should not be forgotten, that the relative importance of physiology is very different in the animal and vegetable kingdoms. In the former, structure and function operate so directly upon one another, that the great groups are, to a certain extent, defined by well-marked external characters, which are at once recognizable by the student, and are familiar, or at least intelligible, to those even who have paid no attention to natural history. In the vegetable kingdom this is by no means the case: the processes of assimilation and secretion present but little of that complication which renders the study of animal physiology so important; they are, on the contrary, uniform almost throughout its whole extent, and moreover so simple in their *modus operandi*, that this very simplicity prevents their being rightly understood. In consequence, even the two great classes of Monocotyledons and Dicotyledons are not distinguishable without considerable practice and study; and were we dependent upon actual inspection of the organs whence the essential characters of these two groups are drawn, for the means of recognizing them, Systematic Botany would be an impracticable study.

Herein lies one great obstacle which meets the beginner on the very threshold of his botanical studies: he sees the great divisions of the animal kingdom to be recognizable by mere inspection, and that familiar characters are also natural, and available for purposes of classification: the very names of the groups convey definite information, and to a great extent give exact ideas. Birds, fishes, reptiles, etc. are all as natural as they are popular divisions; but what have we in the vegetable kingdom to guide the student through the two hundred and fifty natural orders of flowering-plants? As with a new language, he must begin from the very beginning, and also avail himself of artificial means to procure as much superficial knowledge of structure and affinity as shall enable him to see that there is a way through the maze. Hence the obvious necessity of an artificial system of some sort to the beginner, who has, at the same time, to master a terminology, which,

if not so complex as that of zoology, is more difficult at the outset, from the want of standards of comparison between the organs of plants and those he is familiar with in himself as a member of the sister kingdom. Applying these remarks to practice, the botanical student finds that he has much to unlearn at the very outset; in many cases he has misapplied the terms root, stem, leaf, etc., and contracted most erroneous ideas of their structure and functions; while he is startled to find that the popular divisions of plants into trees, shrubs, and herbs,—leafy and leafless, water and land, erect, climbing, or creeping,—are valueless even as guides to the elements of the science.

It is not however to be supposed, because pure physiology is of secondary importance to the right understanding of the affinities of plants, that botany is therefore a less noble or philosophical study than zoology; since we find anatomy, development, and morphology, occupying a very far higher rank in proportion. Being deprived, as he is in most cases, of all technical aids to the determination even of the commoner exotic natural families, the systematist is compelled to commence with the knife and microscope, and can never relinquish these implements. Systematic Botany is indeed based upon development; and no one can peruse, however carelessly, the most terse diagnosis of a natural order or genus of plants, without being struck with the variety and extent of knowledge embodied as *essential* to its definition and recognition. Not only are the situation and form, division or multiplication, relative arrest or growth, of the individual organs exactly defined, in strictly scientific and scrupulously accurate language, but the development of each is recorded from an early stage: the vernation and stipulation of the leaves; the æstivation of the young calyx and corolla, and their duration relatively to other organs; the development and cohesion of the stamens; the position and insertion of the anther; its pollen; the cohesion or separation of the carpels, and the stages of their development from the bud to the mature fruit,

and from the ovule to the ripe seed, are all essential points; all, however minute, must in many cases be actually inspected before the position of a doubtful genus can be ascertained in the Natural System; and this is not the exception, but the rule.

The necessity for acquiring so extensive and detailed a knowledge indicates a power of variation in those organs from which the natural characters are drawn, that defeats any attempt to render one, or a few of them only, available for the purposes of classification; and hence it is that the study of morphology, or the homologies of the organs, becomes indispensable to the systematist: by this he reduces all anomalies to a common type, tests the value of characters, and develops new affinities. The number, form, and relative positions of organs may supply technical characters, by which observers of experience recognize those natural orders under which a great number of plants arrange themselves; but a knowledge of structure and anatomy alone enable the botanist to progress beyond this, and to define rigidly: whilst the study of development affords him safe principles upon which to systematize and detect affinities, and morphology supplies the means of testing the value of the results, and reveals the harmony that reigns throughout the whole vegetable world.

Physiology, again, is a branch of botany very much apart from these: its aim is the noblest of all, being the elucidation of the laws that regulate the vital functions of plants. The botanical student of the present day, however, is too often taught to think that getting up the obscure and disputed speculative details of physiology, is the most useful elementary information he can obtain during the short period that is given him to devote to botany*; and that, if to this he adds the scru-

* As we are writing in the hope of being useful to our medical brethren amongst others, we may be excused from remarking here, that it is not to the credit of our medical curriculum, that, travel where we will, we find the medical man deploring his inability to apply the knowledge of botany obtained at his college, to any useful purpose. The little he has learned about the names and functions of organs he might easily have acquired at school, and thus have been prepared to devote the whole period of his botanical studies to the practical ap-

tiny of a few of the points under a microscope, he has made real progress as an observer. This, we maintain, is no more botany, than performing chemical experiments is chemistry, or star-gazing, astronomy. A sound elementary knowledge of vegetable physiology is essential to the naturalist, and should indeed be a branch of general education, as it requires nothing but fair powers of observation and an ordinary memory to acquire it. For the student to confine his attention to this knowledge of the vegetable world, and to try and improve upon it by crude experiments of his own, undertaken in ignorance of the branches of pure botany we have enumerated, is a very rational amusement, but nothing more.

A review of the progress of the science in England during the last fifty years, proves indisputably, that more botanists were made by the thorough grounding in classification to which all students were formerly subjected, than by the present method of commencing instruction with anatomy and physiology, organic chemistry, the use of compound microscopes, and similar abstruse subjects, which are mysteries to the majority of students. The latter are indeed, in too many cases, perfectly ignorant of the elements of natural science, and require some practical acquaintance with plants and their organs, before they can appreciate the relations of the different branches of botany to one another, or discriminate between what it is essential to understand first, and what is better acquired afterwards. Were the elements of science taught at schools, this would not be so: we should then have the student presenting himself at the botanical lectures fully prepared for the more difficult branches of the science, and for making that progress in them, for which the professor's aid is indispensable. A sound practical knowledge of system we hold to be an essential preliminary to the study of the physiology of

plication of the Natural System, as illustrated by medicinal plants and their properties. The botanical class would not then be considered, as it now universally is, as time thrown away, and an interference with the legitimate studies of the medical student,—an opinion also shared by many of the professors.

plants,—a study which requires also a practical acquaintance with organic chemistry, consummate skill in handling the dissecting knife, and command over the microscope, a good eye, a steady hand, untiring perseverance, and above all, a discriminating judgment to check both eye, hand, and instrument. A combination of these rare qualities makes the accomplished vegetable physiologist, and their indispensability gives physiology its pre-eminence in practice.

III. *Subjects of Variation, Origin of Species, Specific Centres, Hybridization, and Geographical Distribution.*

It has been with no desire of obtruding our views upon our readers that we have ventured to discuss these obscure subjects with relation to Indian plants, but from a conviction, that in the present unsatisfactory state of systematic botany it is the duty of each systematist to explain the principles upon which he proceeds; and we do it not so much with the intention of arguing the subject, as of pointing out to students the many fundamental questions it involves, and the means of elucidating them.

To every one who looks at all beneath the surface of descriptive botany, it cannot but be evident that the word *species* must have a totally different signification in the opinion of different naturalists; but what that signification is, seldom appears except inferentially. After having devoted much labour in attempting to unravel the so-called species of some descriptive botanist, we have sometimes been told that the author considers all species as arbitrary creations, that he has limited the forms he has called species by arbitrary characters, and that he considers it of no moment how many or how few he makes. So long as this opinion is founded on conviction, we can urge no reasonable objection against its adoption; but it is absolutely necessary that the principle should be avowed, and that those who think the contrary should not have to waste time in seeking for nature's laws in the works

of naturalists who seek to bind nature by arbitrary laws. So again with regard to specific centres; except we are agreed with an author as to whether the same species has been created in one or more localities, and at one or more times, we shall be at cross purposes when discussing points and principles relating to identity of species and geographical distribution.

Great differences of opinion have from the earliest days of science always existed on the nature of species. The prevalent opinion has undoubtedly at all times been, that a species is a distinct creation, distinguishable from all others by certain permanent characters. Many eminent philosophers, however, have taken a contrary view; of these the best known have been Lamarck, and more recently the anonymous author of the 'Vestiges of Creation.' Into the arguments on either side it is not now our intention to enter; indeed we could not do so without occupying more space and time than are at our disposal. A most masterly view of the present state of the question will be found in Sir C. Lyell's 'Principles of Geology,' where the arguments of Lamarck and others are stated with great fairness, and answered by the author, whose opinion is decided in favour of species being definite creations. In this we are disposed to agree, having seen no argument which is sufficient to alter the *à priori* conclusion to which facts appear to point, that it is more probable that species should have been created with a certain degree of variability, than that mutability should be a part of the scheme of nature. This however is pre-eminently a question for systematists. Long and patient observation in the field, and much practice in sifting and examining the comparative value of characters, can alone give the experience which will warrant the expression of a decided opinion on a question of so much difficulty.

It cannot be doubted that the general acceptance which the doctrine of the mutability of species has met with amongst superficial naturalists, has originated in a reaction from early impressions of the absolute fixity of characters. The student

who is taught that species are definite creations, constant and unchangeable, without being cautioned as to their power of variation within certain limits, finds, when he begins to observe for himself, that he has constant difficulty in determining their limits, and that abler judges than himself are equally at fault. The more books he consults, the greater are the discrepancies he meets with; if he has recourse to gardens, he there finds species still more sportive; and if he travels, he meets with a change of form under every climate; till at last, perplexed and mortified, he gives up the study of specific botany, and becomes a convert to the belief that species are the arbitrary creations of systematists. And such must be the result in the great majority of instances, while each observer has to acquire for himself that familiarity with the amount of variation to which organized beings are subject, which alone will render him a sound systematist. For so long as our early education does not teach us this important principle, so long shall we find beginners refusing to accept the conclusions arrived at by abler botanists.

Even if we admit the hypothesis that the existence of species as definite creations is inconsistent with facts, it does not necessarily follow that the study of systematic botany is fruitless; for such a supposition involves the operation of laws which govern the variations of plants, and in accordance with which they remain fixed for a longer or shorter period; and such laws it becomes the duty of the systematist to develop. The advocates for their agency principally base their belief upon hybridity, and variability induced by climatic influences; but we shall attempt to show, that all the legitimate conclusions which can be drawn from a study of these phenomena are opposed to the theory of universal mutability.

A. *On the effects of Hybridization.*

Recent experiments have led to the following results:—

1. It is a much more difficult operation to produce hybrids, even under every advantage, than is usually supposed. The

number of species capable of being impregnated even by skilful management, is very few; and in nature the stigma exerts a specific action, which not only favours and quickens the operation of the pollen of its own species, but which resists and retards the action of that of another; so that the artist has not only to forestall the natural operation, but to experience opposition to his conducting the artificial one.

2. Even when the impregnation is once effected, very few seeds are produced, still fewer of these ripen, and fewest of all become healthy plants, capable of maintaining an independent existence; this is a very important point, for under the most favourable influences the average number of seeds that are shed by a healthy plant in a state of nature come to nothing, chiefly owing to the pre-occupation of the soil and the wants of the animal creation.

3. The offspring of a hybrid has never yet been known to possess a character foreign to those of its parents; but it blends those of each, whence hybridization must be regarded as the means of obliterating, not creating, species.

4. The offspring of hybrids are almost invariably absolutely barren, nor do we know an authenticated case of the second generation maturing its seeds.

5. In the animal kingdom hybrids are still rarer in an artificial state, are all but unknown in a natural one, and are almost invariably barren.

On the other hand, it is often argued that hybrids are common in gardens, and that their occurrence in a state of nature cannot be denied; and that if the permanence of one such hybrid be admitted, the whole fabric of species is shaken to its foundation. Such summary conclusions are however opposed to philosophical caution: the whole subject is one that cannot be cleared up by a consideration of exceptional cases; it must be argued upon broad principles, and unfortunately no argument has ever been adduced that has not been taken in evidence on both sides of the question. This is especially the case with hybridization, which, in so far as it can produce a

form distinct from either parent, does, in one sense, create what may temporarily pass for a species; and in so far as the hybrid combines the characters of both parents, it temporarily obliterates the distinctive characters of each. All, then, that we could legitimately conclude from these facts is, that were hybrids of universal occurrence, they would have obliterated all traces of species, but that, exceptional in art, and not proven if not almost impossible in nature, they cannot be assumed to have produced any appreciable result.

There are, however, other points connected with the subject of hybridity, which are of practical importance to the systematist; and in the first place, the fact of its being generally assumed by continental botanists that hybrids do occur in nature, must not be overlooked. Thus we have so-called hybrid gentians in the Jura, and hybrid thistles in Germany; whence the possibility of similar productions occurring in India is to be borne in mind. It is, however, a singular fact, that these hybrids are vouched for only in genera most notoriously apt to vary, and mainly by hair-splitting botanists. In the course of our extended wanderings, it has been our habit to acquaint ourselves with the plants as we gathered them, and so to observe their differential characters in the field, that we were never at a loss for the means of understanding one another when alluding to any particular species; yet we never met with a plant that suggested to us even a suspicion of hybridization. Dr. Wallich, whose tropical experience is probably greater than that of any other botanist whatever, and whose mind and eyes were always open to seize characters and discriminate species, makes the same remark. Griffith, a man of singular powers of observation, and whose experience was very great, never alludes to the subject; nor is the existence of hybrids in nature ever noticed in the pages of Roxburgh, Jack, Wight, or Gardner (of Ceylon)*. It is very true that

* M. Jordan has not unfrequently, it would appear, found that seeds collected on particular species have produced a different form, and he has not hesitated to infer that the ovules of the plant had been impregnated by a different

all this proves nothing; but when we add the tacit acquiescence of Robert Brown, and of all other botanists who have lived amid a tropical vegetation, and devoted themselves to its study, it will not be considered surprising that we should suspect such evidence as has hitherto been adduced by local observers only, and in very limited areas.

The subject of hybridization is however well worthy of the attention of the tropical botanist; and both in his garden and in the field, he should keep his attention always alive to the importance of observing every phenomenon that may bear upon its agency, and should institute operations that will throw light upon the subject.

B. *On Variation of Species.*

Although the researches of naturalists have not hitherto led to the detection of those laws in obedience to which many species of plants vary much in one climate and less in others, or remain constant throughout many climatic conditions, they indicate the operation of certain general laws, whose effects are as follows:—

1. Contiguous areas, with different climates, are peopled by different species of plants, and not by the same under different forms. 2. Similar climates in distant areas are not peopled by the same or even similar species, but generally by different natural orders of plants. 3. Both contiguous and remote areas contain a certain admixture of species common to two or all of them, which retain their individuality under every change of climate.

These are generally admitted facts; there are however exceptions, upon which are based the arguments for attributing to climatic effects the creation of many species from one variable type. Careful observation reveals many such exceptions; and the tendency which plants display to revert to one typical

species. The contrary inference, that species are subject to a certain amount of variation, does not seem to have occurred to him.

form, is often the only guide we have to their origin. To us it appears that but one legitimate conclusion may be drawn from the facts; and that, taking the broadest view of the case, while it is difficult, on the one hand, to reconcile the acknowledged tendency of varieties and hybrids to revert to their original state, with the fact that the floras of remote areas, possessing similar climates, are permanently and prominently different in their main elements; on the other, it is equally remarkable that the majority of the plants found wild or cultivated in all climates, are not specifically changed by any; and this, whether they are of species that have been thus widely spread for ages, or such as have been introduced by man in later times.

In the Botanical Gardens at Calcutta many thousands of plants from all parts of the world have been cultivated with more or less success, and some have become denizens of the soil; but in no instance has such a change of character been produced as could justify the suspicion that specific marks might be obliterated by even such violent contrasts of climate as Calcutta and Australia, or Calcutta and the Cape of Good Hope, afford. On the contrary, the seedlings seem infallibly to resemble their parents for generation after generation, altered perhaps in size, and more frequently in habit, and accommodating themselves to the seasons of India, but remaining true to their botanical characters.

With regard to the specific effects of climate on plants, they are extremely difficult of appreciation, the observer seldom having the opportunity of becoming familiar with the same species under very different climatic influences, at one and the same time. This is, however, an essential point, for nothing is so fallacious as recollections of the habit and general appearance even of very familiar plants. We have ourselves repeatedly gathered some of the commonest English weeds in foreign countries without recognizing them, though they differed in no respect, even of habit, from those we had been familiar with from childhood,—so deceptive are the ef-

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fects of local circumstances and temporary associations, which give a foreign colouring to everything surrounding them.

The following remarks on the relation between climate and the development of species in India, though crude, may prove suggestive to those enabled to pursue this subject. Although India presents greater contrasts of climate than any other area of equal size in the world, we do not find that those genera and species, which prevail over all its parts, are so variable in any respect as are the plants of some countries which enjoy a more uniform climate; as an example, we may say that the species forming the flora of New Zealand are, as a whole (proportionately to the extent of the flora), far more variable than those of the mountains or plains of India. Could this fact be expanded, and, being confirmed in a wider survey, be proved to be of general application, it would be one of the most important data to start from in the investigation of those laws that regulate the development of varieties; but we are not prepared to say that a comparison of the species which inhabit the excessive climates of different parts of India with those that inhabit the uniform climates, supports this view: for instance, the central or temperate regions of the Himalaya, where perennial humidity and coolness prevail, are not peopled by very variable genera and species, whilst the alpine regions that are characterized by an excessive climate are so, and the annuals of the hot plains are peculiarly sportive in stature, habit, hairiness, foliage, and number and form of their smaller organs.

Another point, intimately connected with the question of the power of climate in producing change in species, is the relation that exists between the climate of an area, and the number of species that inhabit it; and this affords a fertile and most interesting field of inquiry in India, where so many climates may be met with in a comparatively limited area. A few facts have appeared to us worthy of notice, though as yet far from well established: as that the equable climate met with on the cool parts of the Khasia mountains and temperate regions of the Himalaya, and on the hot humid coasts of Bengal

and the Malay peninsula and islands, produce an abundance of well-marked species of plants, whilst the dry, hot, lower hills of Central India, with contrasted seasons, produce comparatively few, and none presenting any great difficulties to the systematist; as also that the plains of the Gangetic valley and of the peninsula, which have marked seasons, are comparatively poor in species, whilst those of the Cape, Australia, and South America, also having decided summer heat and winter cold, abound in species. Such discrepancies prove how subtle an element climate is, and how extremely cautious the naturalist should be in generalizing upon its effects. They especially warn us not to consider the influence of climate as paramount in determining the distribution of species or prevalence of forms. We learn from them also that the *primâ facie* evidence in favour of definite creations is not to be lightly put aside; and they suggest the propriety of instituting observations in proportional botany, as that branch of the science may be called, which develops the relations between the number of orders, genera, and species, contained in an area, and its climate and other physical characters.

And now that we are on the subject of variation, it appears advisable to impress upon the Indian botanist the value of studying its phenomena in the field. We pledge our experience that he will find it the most profitable department of systematic botany he can pursue; and that the result of his investigations will be that he will take a wide and extended view of the variations of species, consistently with their still possessing certain definable limits. We shall offer a few remarks on this point under two heads:—variation of parts of the same individual, and variation between different individuals of the same species.

1. *Variation in organs of the same individual plant.* From the luxuriance of the vegetation with which the Indian botanist is so often surrounded, and the rapidity of its development, he has advantages for pursuing this inquiry that observers in colder climates do not possess. In general terms,

the most important groups of phenomena requiring elucidation and careful description are,—1. The changes that accompany the growth of individual organs from the seedling state to the decaying plant. 2. Variations in the same organs, as displayed in different parts of the same individual. 3. Variations in the development and distribution of the sexual organs in plants with unisexual flowers, and in bisexual plants.

It is to our neglect, and often to our ignorance, of the changes in form that so many organs undergo during the different stages of the life of the individual, or of the different form under which they appear in different parts of the same individual, that we owe so many of the spurious species which crowd the pages of our systematic works; and it is to the want of that early training to habits of observation in the field, which we have so strenuously advocated, that is to be attributed the rarity of that power of discrimination between essential and non-essential characters, which alone can make an observer a sound systematist. We therefore earnestly recommend to the Indian botanist the detailed study of individuals and their organs*, with the view of determining their limits of variation. In relative size especially, the observer will find immense variation; for, unlike the animal creation, proportional dimensions are of small moment in the vegetable kingdom. This fact, so familiar to the botanist of experience, is always a puzzle to the zoologist, who fancies he perceives a vagueness and want of exactness in all botanical writings (except in those of the too numerous class that make a parade of measuring to lines organs that vary by inches), that contrasts unfavourably with descriptive zoology. Symmetry again is only a relative term amongst plants, for even such leaves as grow in pairs are never alike, and often differ much in form, texture, and colour; whilst the various sepals, petals, etc., of an individual flower, never so exactly correspond, as the relative members of an animal do; and there are

* In Wight and Arnott's 'Prodromus,' p. xxi., this point is especially dwelt upon, and a warning given to beginners, which has been too little attended to.

still greater differences between these organs, when taken from different flowers. And however carefully we investigate the anatomy of a plant, we never fail to find similar deviations from ideal regularity prevailing; for even the number of ovules (when more than two) varies in the different cells of one ovarium, as do the number of ovaria in flowers that bear several*. As regards variations in the floral organs, these are apparently more likely to occur, the less the individual parts deviate from the normal type (the leaf), of which they are modifications; as if the more complete adaptation to a special function rendered them less liable to casual variation. We find, for instance, that the carpels of Ranunculaceous plants vary much in shape, while those of *Umbelliferæ* and *Compositæ* are almost constant; and that the sepals of *Rosa* and *Pæonia* present remarkable variations of form, while those of *Dianthus* and *Kalanchoe*, which are united into a tube, retain their form, with scarcely any modification, in each species†.

2. *Variation between different individuals of the same species.* This is a more fertile source of spurious species than that last treated of, and, in our opinion, the neglect of its effects has mainly contributed to such a multiplication of species in the vegetable kingdom, as botanists unfamiliar with large herbaria and exotic plants are slow to believe; and to the exaggerated estimates of the supposed known extent of the vegetable creation that gain common credence. We feel safe in saying

* It is hardly necessary to allude to the desirability of studying the various forms induced by artificial causes: the browsing of cattle on shrubs, for instance, which is almost invariably followed by an abnormal state of foliage on the subsequently developed shoots, has been a prolific source of bad species; while there is scarcely an operation of man that does not tend to produce change in the vegetation surrounding him.

† The shape of floral leaves and bracts is, in general, much less constant than that of the perianth. It is important to bear this in mind in many families of plants. We could especially notice, as an instance, *Coniferæ*, in which the scales of the cone are very generally relied on as affording specific characters. If botanists who have an opportunity would examine and record the degree of variation which occurs in the shape of the scales of the cones of the individual trees, in the Indian species of Pine, especially *Abies Webbiana*, and its variety *A. Pindrow*, a great benefit would be conferred upon science.

that the number of known plants is swelled one-third beyond its due extent, by the introduction of bad species founded on habit, and on accidental varieties produced by soil, exposure, etc. This subject admits of classification under two heads, to neither of which can we be expected to devote much space in this Essay.

1. There are accidental variations due to no apparent causes or to very fluctuating ones, as colour of flowers and leaves, odour, hairiness (to a great degree), development of parts, strength of medicinal or other properties, hardness and various properties of wood, and many others. 2. More permanent deviations that accompany change of locality, and affect more or less all the individuals inhabiting a certain area: these may often be traced to physical causes, and give rise to races and stocks, which are more or less permanent under cultivation and changed conditions, such as habit, hardiness, and duration of life and of foliage (evergreen or deciduous), predilection for certain soils and exposures, and other characters which are more or less obviously induced by operations that have extended through a series of generations.

Gregarious plants, in all states, whether wild or cultivated, and field-crops in particular, offer excellent opportunities of studying these phenomena. Nor are these remarks applicable to herbaceous or shrubby plants only: even in this country the variations of the recently introduced Deodar are already attracting attention to the question of its specific diversity from the Cedar of Lebanon and that of North Africa*.

* As regards the specific differences between the common Cedar and Deodar, we think the question still open to discussion. We have no fixed opinion on the subject, and in the present incomplete state of our knowledge we recommend caution. The prominent difference strongly urged is founded on error; *i.e.* that the scales of Cedar-cones are persistent and those of the Deodar deciduous; the fact being that the Cedars at Kew and elsewhere scatter their cone-scales whenever a warm summer ripens their wood. As to the differences of timber, that of the Cedar is so very variable as to throw suspicion on the value of this character; and other trees, as we have elsewhere said, present immense difference. The odour and quality of Cedar-wood varies according to the circumstances under which the trees have been grown. Length and colour of leaf, and habit,

The varieties that may be selected from a plantation of seedling Spruce, Larch, or Yew plants are innumerable; but so led away are observers by dominant ideas as to the form and habit that plants should assume, that similar differences in other species are seldom put down to a similar power of varying, as *à priori* they should be, but are taken as evidence of specific difference. To this proneness to attach undue importance to variation, we owe the separation of *Pinus Pindrow* from *Webbiana*, *P. Khutrow* or *P. Morinda* from *P. Smithiana*; nor is this all, for species have been made of the commonest English plants which grow in the Himalaya, because they present differences of habit when compared with English individuals, but which plants, if compared with continental specimens of the same species, are found to be identical with them: to such an extent has this been carried, that of the several hundred European plants found in India, there is hardly a species that has not had one (and many, more) new names given to it.

The differences in the properties of plants and in the colour and durability, etc. of woods, demand a short notice, because the idea is too prevalent that these are very unvarying diagnostic properties of species. That some woods are always good, and some as constantly worthless, is incontestable; but this applies chiefly to those of very remarkable hardness or density or weight, or other very unusually marked quality; and even of these, the Teak, Sissoo, Sal, etc., each vary much in quality, whilst the wood of other kinds is singularly variable, as of the Indian Pines, Oaks, Laurels, Ebonies, etc. With regard to the Pines, this is very much to be attributed to the soil and climate, and consequent rapidity of growth

are so sportive in the Deodar, that we have seen many specimens of it that are as unlike what we call the typical Deodar, as they are unlike the Cedar; and others that approach the latter very closely. There are very slight differences in the shape of the cone-scales of the Deodar, Cedar, and Algerine Cedar, which have never been indicated, and may be of value: but we doubt their proving so, from the fact of the Algerine Cedar, in this respect, approaching the Himalayan, and thus uniting all three.

and development of resinous qualities. Thus the wood of the English-grown Lebanon Cedars differs greatly in colour, hardness, and odour; and the Swiss Larch and Scotch Pine, when planted in England, yield very inferior timber compared to what they do in their native forests. The wood of the English Oak grown at the Cape of Good Hope is worthless, as is that of the American Locust-tree, and indeed of most American timber-trees, in England. The varieties of Oak* wood in our own climate are no less notoriously different; and the endless discussions that have arisen as to the relative properties of timber-trees, and the specific differences between the plants that produce them, may to a great extent all be traced to the same cause.

With regard to the development of medicinal properties they vary extremely in the same species. Of this the most conspicuous Indian examples are presented by the Opium Poppy, Mudar (*Calotropis*), and the *Cannabis sativa*, the common Hemp of England, which yields Bhang and Chirris in varying quantities, and of different quality, very much in proportion to the humidity of the soil and climate it grows in. The *Digitalis* grown in the Himalaya is said to have proved almost inert, and so with other plants which have been cultivated for medical and economic purposes, as the Tea and many English fruits and vegetables.

We have reserved habit as the last point to which we shall allude in connection with this subject, though we believe it to be of all others the most deceptive, as indicating specific difference. Habit is a thing which every one thinks he appreciates, but which no two persons similarly appreciate; each individual's conception of it depending on his own knowledge and experience, usually on first impressions, and often on preconceived ideas which become dominant. Like all other vague terms, it is used with as much confidence by a gardener to

* We do not here allude to the difference between *Quercus pedunculata* and *sessiliflora*, but to that between the wood of the same species or variety, as grown in different climates.

discriminate varieties, as by the botanist to distinguish species. The student should be on his guard to avoid being led astray by dominant ideas on this subject, and fancying that the aspect of a species to which he is most accustomed is the typical one of its race. Let him examine well, in their native forests, the Pines (those most variable of plants). Let him compare *Pinus longifolia* from a deep dell in the humid atmosphere of Kumaon, Nipal, or Sikkim, with the same tree growing on a sandstone rock in the arid climate of the Panjab. Let him contrast the Larch of Switzerland or the Tyrol, with that cultivated in our English plantations, or the common Scotch fir of the sandy plains of North Germany, with the same tree on the higher Alps; or attempt to give limits to the variations of the Yew-tree everywhere, whether wild or cultivated. Our Junipers, Willows, Birches, and Roses, will afford in abundance similar instances of great mutability of form, with no modification of essential characters; and the gardener makes of one and the same species, or even variety, a standard or espalier, a tree or shrub, an erect or decumbent plant. Most of these instances, and many others, must be familiar to botanists; yet we believe we shall meet with few supporters in the opinion we have formed, and to which direct observation has led us, that habit alone, when unaccompanied by characters, in the organs of reproduction especially, is of no specific weight whatever.

As we write, a hundred instances of protean habit in Indian plants crowd upon our memory. The common Yew, which is indigenous throughout the whole length of the Himalaya and in the Khasia mountains, wherever it grows in the deep forests is a tall tree, with naked trunk, rivalling in dimensions the giant pines and oaks with which it is surrounded; on the skirts of the same forests it is a lax, almost prostrate bush, while on open slopes it becomes a stout, dense, tabular-branched tree. The Rose, Spiræa, and Berberry of the Western Himalaya are truly protean in character, being abundant in all situations,—whether forming underwood in forest, or

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growing on open slopes. The common Junipers defy all attempts at circumscription by habit, and so do the Cotoneasters. The Himalayan Box (*Sarcococca*), like that of Europe, is now an undershrub and now a tree. The *Hippophae* and *Myricaria* of Western Tibet, which are first met with as trees, as they ascend to colder regions dwindle down to little shrubs, stunted and almost prostrate; while *Ephedra*, an erect shrub, two feet high, on the Indus, at 7000 feet, in the more humid climate of Kunawur sends out long, lax, whip-like branches, and at 15,000 feet is scarce an inch long. Let any one recal to mind the gigantic Sal, with tapering trunk, in the Terai forest, and the gnarled tree it becomes on dry slopes; or contrast the noble Sissoo near a village in Upper India with the slender, pale, and apparently sickly (yet really robust and healthy) inhabitant of the gravelly banks of streams at the base of the Himalaya; or the wild Jujube, an undershrub, not a foot high, with the same plant cultivated as a spreading tree. Many figs have straight, erect, unsupported trunks, in open dry places, yet in humid forests the same species send down thousands of roots from their branches, like the Banyan. Most of the Indian annuals are, in like manner, multiform; being tall, slender, and delicate, in moist grassy places, during the rains, and prostrate and wiry in open spots, and at a drier season: this is especially the case with the little *Cassiæ* of the Mimosoid group, with various *Indigoferæ* and *Alysicarpi*, and even with *Æschynomene*.

The universal recognition of the importance of habit, as a character upon which to found specific distinction, is the more surprising, when we consider how many well-marked varieties are distinguished mainly by habit, and, though very permanent when the plants are increased by cuttings or grafts, soon disappear when they are raised from seed. The weeping birch and ash are good instances of this, as well as the Lombardy poplar—a diœcious tree, of which one sex only is known, and that in cultivation, and which appears to be nothing more than a tapering state of *Populus nigra*, accidentally produced,

and perpetuated by cuttings. Similar examples are afforded by all our domestic fruit-trees, among which, by a practised eye, many different sorts can be recognized at once.

In conclusion, the majority of our readers will smile when we add that the general impression of persons of intelligence, that they know our common English trees at first sight, is to a great degree illusory: we have all an ideal Oak, Elm, Poplar, etc., and we call the specimens that do not come up to that ideal abnormal, and representations of such we say are not characteristic; but let any one keep a watch upon himself in the fields, parks, or forests of countries not his own, yet tenanted by trees specifically the same as those of his own, and we venture to assert that he will find his preconceived ideas fall to the ground in very many cases. We do not mean to say that he will not recognize a park oak, churchyard yew, or weeping willow; but we do assert that he will not recognize by habit the same oak at the Cape of Good Hope, where it is now abundant, or the same yew in a thick forest; and we may add that no Himalayan traveller within our experience has, on his return to England, ever recognized the Deodar at Kew Gardens *by habit* to be the plant of those mountains, and that, on the contrary, we have frequently had the Cedar of Lebanon pointed out as that tree.

It is very much to be wished that the local botanist should commence his studies upon a diametrically opposite principle to that upon which he now proceeds, and that he should endeavour, by selecting good suites of specimens, produced under all variations of circumstances, to determine *how few*, not *how many* species are comprised in the flora of his district. The permanent differences will, he may depend upon it, soon force themselves upon his attention, whilst those which are non-essential will consecutively be eliminated. There is no better way of proving the validity of characters than by attempting to invalidate them. The unavoidable tendency of the human mind, when occupied with the pursuit of minute differences, is to seize on them with avidity, and to relinquish them with re-

gret; hence the irresistible desire to rest contented with a character, however bad, so long as it is obtained with difficulty, and in the observer's opinion is tolerably constant. It is strange that local naturalists cannot see that the discovery of a form uniting two others they had previously thought distinct, is much more important than that of a totally new species, inasmuch as the correction of an error is a greater boon to science than is a step in advance.

C. *Geographical Distribution.*

This, which is in very many respects the most interesting branch of botany, has made very little real progress of late years, owing to the confused state of Systematic Botany; for we do not consider rudely cataloguing the ill-defined species of limited areas, or loosely defining geographical regions by the supposed prevalence of certain natural orders or forms of vegetation, as calculated to advance directly the philosophy of distribution, however useful such regions are to the beginner, or such catalogues to the systematist.

If we take India as the area for examination, we are met at the outset by difficulties that plainly indicate the backward state of Indian Botany. Beginning with the first requirement of the student of geographical distribution, we are literally perfectly ignorant of the numerical value of a single important Indian natural order of plants: turning to their numerical proportions, there are no sufficient data for saying which of the five largest orders in the vegetable kingdom is the most abundant in India, viz. *Leguminosæ, Compositæ, Gramineæ, Orchideæ,* or *Rubiaceæ,* nor in what climates each most prevails; still less do we know how the important tribes of these natural orders are distributed, or what physical features of temperature, elevation, and moisture they indicate, or to what other floras their relative predominance allies that of India. There is no work that pointedly indicates the natural orders peculiar to India, and still less the genera and species. With

regard to the European genera, which in some parts literally form the mass of the flora, we find them but vaguely indicated in our best authorities; and the European and British species have, as we have said already, been almost invariably described as new, without examination or comparison, and many of them more than once or twice. Yet all these elements must be approximately settled before we can attempt a solution of those great questions involved in Botanical Geography, which place it as a philosophical study in the foremost ranks of science: we allude to the laws which govern the development, progression, and distribution of forms and species; the connection of these laws, not only with one another, but with physical features; and their modifications by geological change. We must know at what rate European and African plants disappear in advancing eastwards in India, and Malayan ones in following an opposite direction; how the Chinese, Japanese, and North American genera and species mingle with western forms along the Himalaya and Khasia; and the exact amount of Arctic and Siberian plants, which are spread all over the loftier Himalayas, and descend the valleys of the Indian watershed. And lastly, there are extraordinary anomalies to unravel, or to secure on a basis of accurate observation; such as the absence of Oaks in the peninsula of Hindostan and Ceylon, though they abound on the opposite shores of the Bay of Bengal continuously from the Himalaya to Java; the want of any Pine whatever in the peninsula of Hindostan, and of *Cycadeæ* in Ceylon; and many other points of the highest interest, that have never yet attracted the attention of naturalists, and want illustration previous to explanation.

We cannot pursue these interesting subjects here, nor dare we, in our present ignorance of botanical facts, allude to the connection which we think shadowed out between the geological events that have resulted in the present configuration of the Indian continent and peninsulas, and the lines along which certain groups and species of plants have consequently been distributed.

We have already remarked that the effect of confounding variations with specific differences has been to swell the supposed number of known plants by one-third; and we think that, if mistaken ideas of distribution be added, we shall find that, of the number of species enumerated in catalogues, the proportion that are spurious amounts to at least one-half. Thus, there are not a few botanists who have contributed a very considerable number of such, founded solely on the fact of their supposed isolation, and which were not even compared with their described congeners previous to being thrust as new into the annals of botany. The Indian Flora swarms with these. In the natural order *Ranunculaceæ* alone, comprising 115 species, we have been obliged to reduce 28 supposed species*, founded exclusively on Indian specimens, to well-known European plants, besides a multitude of others, natives of Siberia, Persia, Western Asia, and some eastern Asiatic ones. Of the 27 European *Ranunculaceæ* enumerated, only 4 had previously been identified, and of 17 others all had one or more new names, there being 28 new names in all. When we add, that such plants as the common English Marsh-Marigold, Monks-hood, Columbine, Pæony, Actæa, Crowfoot, Berberry, White Waterlily, and Red Poppy, have all had names lavished on them in virtue of their Indian birthplace, our readers may judge for themselves of the progress that the geographical distribution of Indian or European plants is likely to make for some years to come†. Of the undue im-

* This is a very moderate estimate, for we fully believe that future authors will reduce many other species which we keep distinct, to English forms, especially among the *Ranunculi* and *Delphinia;* we have, however, considered it necessary to prove absolute identity between the European and Indian individuals, before uniting them, which of course obliges us to keep separate many plants which we fully believe to be only Indian forms of well-known western ones.

† The converse of this is equally instructive and illustrative of the point we wish to impress. The Silver Cedar of our parks, so long as its habitat was unknown, was universally considered to be a variety of the Lebanon Cedar: now that it is known to come from Algeria, and not Lebanon, it is considered a different species in standard works.

portance attached to locality, we believe that botanists have no conception. Witness the fact, that several common European garden-plants introduced into the grounds of the British Resident at Katmandu (Nipal), and thence re-imported to England, have been at once put forth in this country as new Himalayan discoveries, and specific characters invented for them. But instances of this multiplication of names are almost incredibly numerous: the common English Yew has two Himalayan names; the *Pteris aquilina* (English Bracken), seven; the eighteen known Indian species of *Clematis* are in Steudel's 'Nomenclator' ranked under forty names; and we may conclude by announcing our conviction, that more than one-half of the recorded species of Indian plants are spurious, and that in many natural orders the undescribed species hardly equal in number those which require to be cancelled.

The fact that almost every Himalayan plant has a vertical range of nearly 4000 feet, and many of 8000, is in itself a suggestive one. Several hundred species are dispersed from the Levant to the Indus, and many more from the Ganges to the Chinese Sea. Such instances of distribution in tropical plants are called strange and exceptional by unreflecting botanists, who forget how many species are common to all longitudes between England and Kamtchatka, or to all the mountains of Europe; or to the Rocky Mountains of America, and those of Scotland and Norway; or to all latitudes between England and North Africa.

The subject of geographical distribution leads to questions of practical importance, upon which we have a few remarks to offer, as eminently bearing upon all questions relating to the treatment of a systematic flora: these are,—1. Its dependence on the doctrine of specific centres. 2. The power of migration as capable of effecting the present distribution. 3. The general effects of migration in producing a much wider dispersion and ubiquitous diffusion of species than is generally admitted by botanists who have not investigated tropical floras, and especially continental ones.

1. As regards specific centres, we proceed in our investigations on the assumption that all the individuals of a unisexual plant proceeded from one originally created parent, and all of a bisexual from a single pair. To discuss this subject would be out of place here: for a *résumé* of the principal facts opposed to it, as well as of those which support it, we must refer our readers to Sir Charles Lyell's 'Principles of Geology,' and to the Introductory Essay to the Flora of New Zealand. It is sufficient for our present purpose to declare, that after many years' unprejudiced careful consideration of the subject in all its bearings, during which period we have been fettered by no professed opinion to support, and have had no inculcated theory to eradicate, we have been independently led to this conclusion, as being most consonant with our very considerable experience in the field and herbarium.

2. In attributing the present dispersion to natural causes, we by no means limit them to existing ones. We have every reason to believe that many living species of plants have survived the destruction of large continents, just as many animals have; that in short they have outlived recent geölogical changes, of whatever magnitude, that they have witnessed gradual but complete revolutions in the relative positions of land and sea, and consequently in the climate of the several parts of the globe. Such an antiquity is proved for shells especially, and to a greater or less degree for all tribes of the animal kingdom; the amount of evidence depending solely on the adaptation of their dead parts to preservation in a recognizable condition. Fossil plants are specifically never thus to be identified, and our argument is hence one founded on analogy only, but supported by many facts* in distribution, not less than by the effects of such operations as we now see in progress.

* Sir Charles Lyell was the first to appreciate this most important element in geographical distribution (Principles of Geology, chap. xxxiii.); and Professor Edward Forbes first brought it to bear upon an existing Fauna and Flora, in his admirable Essay on the 'Distribution of the Plants and Animals of the British Islands' (in the 1st vol. of Mem. Geolog. Survey of U. K.). We

Applying this view to the Indian Flora, we may illustrate it by assuming, as an example, that the majority of the many plants common to the Himalaya and Java migrated over continuous intervening land, which has been broken up by geological causes, chiefly by subsidence; just as the partial subsidence of Java itself would effect a further dismemberment of an area now continuously peopled with plants, and which would result in a cluster of islets, having a vegetation in common. Extending this idea of submergence and emergence of land, one island may at different epochs have been continuous with different continents, from all of which it may have received immigrants. We are very far from denying the active agency of the winds and of animals in aiding distribution, and, to a limited extent, of oceanic currents also; but all the phenomena of geographical distribution, when carefully studied, are so uniform in their nature, and so harmonious, as to demand some far higher and more comprehensive agent than the desultory and intermittent motions of the elements or of animals, to produce the present grouping of plants.

There is a very curious theoretical point bearing upon the distribution of species, first enunciated, we believe, by a most accomplished observer, Dean Herbert, and which, we think, has never been sufficiently appreciated or followed out; it is, that species in general do not grow where they like best, but where they can best find room. Plants, in a state of nature, are always warring with one another, contending for the monopoly of the soil,—the stronger ejecting the weaker,—the more vigorous overgrowing and killing the more delicate. Every modification of climate, every disturbance of the soil, every interference with the existing vegetation of an area, favours some species at the expense of others. The life of a plant is as much one of strife as that of an animal, with this

cannot too strongly recommend this able and original essay to the study of our readers, as the most important contribution to the philosophy of distribution that has ever appeared. We consider the principles embodied to be sound, of universal application, and as necessary to be understood by the student of nature as are the laws of climate and the distribution of heat and cold.

difference, that the contention is not intermittent, but continuous, though unheeded by the common observer. In the common course of events, therefore, the ground occupied by a widely-distributed plant is held on a very different tenure in different places; some individuals are obliged to grow in the shade, others in the sun; and they hence flower earlier in certain places: we say of such plants that they have a power of accommodating themselves to their altered conditions, or better, that they have the power of resisting the effects of the change. Now, this power we believe to be very much underrated, specific characters being too often founded on the differences in habit induced during a plant's migration over great areas, or brought about by the change of soil and climate and surrounding vegetation, to which individuals and their successors are subjected in different parts of one and the same area.

The simple fact that, of all the functions of vegetable life, reproduction is the most uncertain in its effects and results, seems to bear upon this particular point. Some plants are never known to seed; of many, not one ovule out of a thousand ripens into a seed; not one seed out of a thousand germinates, nor one plant reproduces out of a thousand that have germinated. We are too apt to consider such facts, when applied to species or individuals, as indicating that they are not in a natural condition, whereas they appear to be the consequences of a law of nature, and ought to teach us that plants, in a state of nature, are subjected to the operation of external agents, which not only alter their habit but influence their vital functions.

In these somewhat desultory remarks on the various subjects of which we proposed treating, we have endeavoured to illustrate our great argument, the imperative necessity of checking the addition of species on insufficient grounds, and the importance of treating scientifically those that are already known. We consider it to be desirable, that for all practical purposes species be regarded as definite creations, the offspring each of but one parent or pair; we believe that they are en-

dowed with great powers of migration, and that they have been aided in their dispersion primarily by those changes of climate, land, and sea, which accompany, or are effected by what are called geological changes, and secondarily by the elements and the animal creation. Under these convictions, we feel it imperative, on philosophical grounds as well as on those of expediency, to use every effort to reduce the vast bulk of forms we have to deal with in the Indian Flora to as few species as we can, consistently with a careful study of the structural and morphological characters of each. We shall, as a rule, banish from our minds the idea that a species is probably new because hitherto unknown to ourselves or to the Flora of India; we shall, upon principle, keep two or more doubtful species as one, carefully and prominently indicating their differences, and, when expedient, ranking them as varieties; in preference to keeping doubtful species separate till they shall be proved the same; having ample proof that in so doing we shall avoid the greater evil. We shall not think it desirable to adopt the opinions of others in preference to our own* on points where we have had the best materials to judge from. With regard to nomenclature, we shall not alter names established by Linnæus, and usually retained by subsequent botanical authors, upon the ground of their having received prior names before botany was systematized. We shall incline to adopt old established familiar names, though of doubtful applicability, in preference to giving new, even when legitimate to do so. We shall endeavour to retain the first published specific name† of a plant, even when the genus requires to be changed, and shall always give preference to priority of pub-

* This may to some non-botanical readers sound dogmatical, if not presumptuous; but the fact is, that a system is deeply rooted and widely spread, of keeping up known bad species in so-called deference to authorities; in nine cases out of ten, this is done to save the trouble of a re-examination, and in too many, simply to swell catalogues. The same authorities are held very cheap, when they unite what hair-splitters wish to keep separate. Witness the state of the British Flora with regard to Willows, Brambles, and Roses.

† With every wish to bind ourselves by the canons (most of which are ex-

lication, except where there are obvious reasons for the contrary, which we shall explicitly state.

Lastly, we find it necessary to say a few words regarding the employment of the native appellations of plants as specific names. These are in general very uncouth, and disagreeable to those who are unfamiliar with Indian languages; moreover, they are quite unpronounceable without special education in the mode of spelling. The only advantage which they are supposed to possess, is the identification of useful species by their means. This we believe to be an entire delusion, except in a very few exceptional cases, where the native names are so extensively known that they ought to be learned as a part of a language, and not sought for in the catalogues of scientific botany. In general they are mere local appellations, confined to a single dialect of one of the many languages of quite different roots spoken over the area the plant inhabits. Added to this, they are, in by far the greater number of cases, founded on error; and it becomes necessary for the systematist to explain, that the name which, by the laws of priority, is irretrievably placed upon the records of the science, has been misapplied, and ought to be borne by another, and frequently very different plant, or by none at all. We have therefore retained native names with great unwillingness, and have not hesitated to change them wherever it has appeared practicable without violation of established rules.

In conclusion, we may state that in all these points we have only followed the example set by Wight and Arnott in their 'Prodromus Floræ Peninsulæ Orientalis,' a work which is, as regards Indian Botany, unique; and indeed there are few systematic works in our own or any other language, that equal it for accuracy, truly philosophical views of the limits of genera, species, and varieties, and scrupulous attention to the details of nomenclature, synonymy, etc.

cellent) laid down by the British Association for nomenclature in Natural History, we have, in common with every botanist who has tried to do so, been obliged to set them aside in many instances.

IV. *Summary of the labours of Indian Botanists, and of the materials at our disposal for prosecuting the Flora Indica.*

A. *Publications of importance to Indian Botanists.*

The masterly sketch of the progress of botanical science in continental India, which is contained in the introduction to Wight and Arnott's Prodromus, a work which is in the hands of every botanist, renders it unnecessary for us to enter into such full details as would otherwise be requisite, regarding the older Indian botanists and their collections. A brief notice of some works, to which we shall frequently have occasion to refer in the course of our labours, is however desirable.

The earliest scientific work on the Flora of India is the 'Hortus Malabaricus' of Van Rheede (Governor of Malabar), which was published in Holland about the end of the seventeenth century, in twelve volumes, with figures of nearly seven hundred plants. It is a very remarkable book, from the general excellence of the plates, which are faithful representations of the plants. Malabar was for many years so little explored, that till very recently a great many of the plants figured were not familiarly known: within the last twenty years, however, its flora has been investigated by so many botanists, as to be considered nearly exhausted; and as the novelties will consist chiefly of obscure plants, we may conclude that when the collections now in Europe (particularly Wight's) are described, Rheede's plants will be all identifiable.

Rumphius' 'Herbarium Amboinense' is of much less value as a work of reference than that of Rheede, because the plates are in general much inferior. They are often greatly reduced in size, and frequently bear too little resemblance to the plants which they are meant to represent, to render it useful to quote them. The flora of Amboyna is not so well known as that of Malabar, but Blume has done much to-

wards identifying the plants figured by Rumphius, and by so doing has done good service to the antiquarian branch of botany.

The collections of Paul Hermann, a medical man in Ceylon, have been rendered classical from having constituted the materials for the 'Thesaurus Zeylanicus' of the elder Burmann, published in Holland, and afterwards of the 'Flora Zeylanica' of Linnæus. These collections form part of the very valuable herbarium at the British Museum, and are of great service in the determination of many of the doubtful species of Linnæus.

The 'Flora Cochinchinensis' of Loureiro, though it relates to a country beyond our limits, contains so many forms identical with those of Ava and Malaya, that we shall have frequent occasion to refer to it. Father Loureiro, a native of Portugal, resided for thirty-six years in the kingdom of Cochin-China, whither he proceeded as a missionary, but finding that Europeans were not permitted to reside there without good cause, entered the service of the King, as chief mathematician and naturalist*. Though he had no acquaintance with the science of botany, the difficulty of procuring European medicines induced him to direct his attention to native drugs; and with a zeal of which we have unfortunately too few instances, he prosecuted his botanical studies, and so successfully, notwithstanding his want of early education, as to produce a work of standard value. The 'Flora Cochinchinensis' was published at Lisbon, in two volumes quarto, in 1790; and a second edition, edited by Willdenow, with a few notes, appeared in octavo, at Berlin, in 1793. As was to be expected, in a work devoted to the botany of a previously unexplored tropical region, the 'Flora Cochinchinensis' contained a great amount of novelty; but the absence of plates, and a defective terminology, caused by a want of familiarity with the labours of other botanists, render the descriptions

* He styles himself, in his own narrative, "rebus mathematicis et physicis præfectum."

often obscure, so that a number of the genera described by Loureiro have not yet been identified, while others, not being recognized, have been described as new, and re-named by subsequent botanists.

We must refer to the Introduction of Wight and Arnott for full details regarding the illustrious series of botanists*, commencing with König and ending with Wallich, who investigated with so much success the botany of continental India. The volumes of the 'Asiatic Researches,' and of most of the systematic works of the end of the last and beginning of the present century, afford ample proof of the value of their labours; but none of them brought their materials together in the form of a flora, except Roxburgh, whose 'Flora Indica' however remained in manuscript for some years after his death, in 1815. Two editions of it have been published since that period; one, which is incomplete, was edited by Drs. Carey and Wallich; it extends to the end of *Pentandria Monogynia,* but contains many additional plants not contained in Roxburgh's manuscript, and requires therefore occasionally to be quoted; the other, which is an exact reprint of the manuscript as left by its author, is in three volumes, and was published in 1832.

Besides editing this portion of the 'Flora Indica' of Dr. Roxburgh, Dr. Wallich commenced, in India, an illustrated work on Nipal plants, which was the first specimen of lithography ever produced in that country; and after his return to England, he published a series of 296 plates of plants in the 'Plantæ Asiaticæ Rariores,' a work which, with the equally valuable Coromandel plants of Dr. Roxburgh, in three folio volumes, with three hundred coloured plates, forms the principal contribution of the Indian Government to the illustration of botanical science.

The eastern or Malayan Peninsula of India was unknown botanically till it was visited by Jack, whose descriptions of

* Jones, Fleming, Hunter, Anderson, Berry, John, Roxburgh, Heyne, Klein, Buchanan Hamilton, Russell, Noton, Shuter, Govan, Finlayson.

Malayan plants were published in the 'Malayan Miscellanies,' and have been reproduced by Sir William Hooker in the 'Companion to the Botanical Magazine,' and by Dr. M'Clelland in the Calcutta Journal of Natural History.

Dr. William Jack was appointed to the Bengal Medical Service in 1813, and was in the earlier part of his career employed in the ordinary duties of his profession. During the Nipal War of 1814–15 he was attached to the army under General Ochterlony, and had an opportunity of seeing the outer valleys of Nipal, a country which at that time was a *terra incognita* to science. In 1818, while at Calcutta, on a visit to Dr. Wallich, he met with Sir Stamford Raffles, the Governor of the British settlements in Sumatra, who at once appreciated his great merits, and offered him an appointment on his staff, promising him every facility for the exploration of the natural history of that island. This promise was most fully kept; and under the enlightened patronage of one of the most liberal Governors whom the Indian service has ever produced, Jack devoted himself with zeal and success to researches in all branches of natural history. Unfortunately his career was a very short one, as he sank under the effects of fatigue and exposure on the 15th September, 1822, on board the ship on which he had embarked on the previous day to proceed to the Cape of Good Hope. It is evident, from his published papers, unfortunately far too few, that Dr. Jack's botanical talents were of the first order, and that he had thoroughly familiarized himself with the structure of all the remarkable forms of vegetation which presented themselves to him in the peculiarly rich and varied Malayan flora.

Wight and Arnott's 'Prodromus Floræ Peninsulæ Indiæ Orientalis' appeared in 1834. We have already characterized this work as the most able and valuable contribution to Indian botany which has ever appeared, and as one which has few rivals in the whole domain of botanical literature, whether we consider the accuracy of the diagnoses, the careful limitation of the species, or the many improvements in the definition

and limitation of genera and the higher groups of plants. One volume only has been published, the work having been interrupted by Dr. Wight's return to India in 1834. It contains the whole of *Thalamifloræ,* and of *Calycifloræ* down to the commencement of *Compositæ,* including descriptions of nearly 1400 species. A smaller work, entitled 'Contributions to the Botany of India,' contains the peninsular *Compositæ,* elaborated by De Candolle; the *Asclepiadeæ,* by Wight and Arnott, with the addition of the extra-peninsular species collected by Wallich and Royle, by Dr. Wight alone; and the *Cyperaceæ* of Wallich, Wight, and Royle, by Nees von Esenbeck, with valuable annotations by Arnott. Dr. Wight has also published in 'Hooker's Botanical Miscellany' some excellent descriptions and plates of Indian plants, and Dr. Arnott has communicated various detached memoirs to the botanical periodicals of the day.

On his return to Madras Dr. Wight conceived the idea of carrying out, on a very extensive scale, an illustrated work on the plants of India, and in 1838 the 'Illustrations of Indian Botany' were commenced, and soon after were followed by the 'Icones Plantarum Indiæ Orientalis.' The former work, which is furnished with coloured plates, contains a series of memoirs on the Natural Orders, full of important information with regard to species, and valuable notes on their affinities: it terminated with the end of the second volume and the 182nd plate, in 1850. In the Icones, the letterpress usually contains only the descriptions of the species, though in the later volumes occasional general details are given, especially in those natural orders which are not included in the Illustrations. The plates of the Icones are uncoloured, and amount to 2101, a surprising number, when we bear in mind that they were commenced only fifteen years ago, and take into consideration the excellence of the execution of the later ones. In the 'Spicilegium Neilgherrense,' a third illustrated work, there are coloured copies of a portion of the plates of the Icones, with much valuable matter relative to the Nilghiri

Flora. This is not the place to dwell on the extraordinary exertions in the cause of science of the author of these great works. They are themselves the best proof of his wonderful energy, and show what can be accomplished by perseverance under apparently insurmountable obstacles. At the period of the publication of the earlier numbers the art of lithography was in a very rude state in India, and the plates are consequently very imperfect; but in the later volumes the improvement is great, and the outline drawings are admirably reproduced. The volumes form the most important contributions, not only to botany, but to natural science, which have ever been published in India, and they have been of the greatest service to us throughout our labours.

Besides these great works, Dr. Wight has published many minor papers in the various periodicals of the day, particularly in the 'Madras Journal of Science,' and in M'Clelland's 'Calcutta Journal of Natural History.'

Mr. Bentham's eminent services to Indian botany demand especial notice here; and while recording our sense of the value of his labours and our admiration of his writings, we would most strongly recommend to the student of Indian botany the careful study of his works, as those of the most industrious, able, useful, and philosophical systematic botanist of the age, who, for correct appreciation of the value and limits of genera especially, is not surpassed by any systematist. His connection with Indian botany commenced by his taking a large share of the labour of distributing the Wallichian collection in 1829, in conjunction with Dr. Wallich, and he again volunteered his services to assist that eminent botanist in the second distribution, that of 1849; he has also been actively engaged in the arrangement and naming of the extensive collections sent by Major Jenkins to Sir William Hooker, by Mr. Griffith to Dr. Lemann and Sir William Hooker, as well as by Dr. Stocks and Mr. Edgeworth to his own herbarium. Of his published works, the monographs of *Scrophularineæ* and *Labiatæ* are of standard excellence, and have

been incorporated into De Candolle's Systema. These, and his Florula of the Island of Hongkong, in 'Hooker's Journal of Botany,' connect his name most intimately with the progress of Indian botany; it is however impossible here to indicate the long list of memoirs he has published, and which more or less bear upon the subjects discussed in this Essay.

Since the date of publication of Wight and Arnott's Prodromus, the great work of De Candolle, the 'Prodromus Systematis Regni Vegetabilium,' has advanced from the fourth to the thirteenth volume; and as the rich materials for the Indian Flora, especially those collected by Wallich, were communicated to its author, the Prodromus contains a very complete *résumé* of our knowledge of Indian botany up to the period of publication of each natural order. This materially facilitates the study of the Corolliflorous Orders, the most important of which have been worked up by Mr. Bentham. With regard to the Thalamiflorous and Calyciflorous Orders previous to Compositæ, these, with the exception of the Peninsular ones, have for the most part to be worked out *ab initio* for the Flora Indica; the earlier volumes of the Prodromus being to a great extent compilations, and particularly defective in all that regards the vegetation of Asia.

Next in point of botanical importance comes Dr. Royle's 'Illustrations of the Botany of the Himalayan Mountains,' in two volumes quarto, with 100 plates. This is the only book except Dr. Wallich's 'Tentamen Floræ Nepalensis,' devoted to the rich flora of these mountains; and it further contains the first and only attempt to demonstrate the prominent features of the geographical distribution of Northern Indian plants in reference to the elevations and climates they inhabit, and to the botany of surrounding countries. A vast amount of valuable miscellaneous botanical matter is here brought together, with characters of a considerable number of species. These, however, are rather to be regarded as indications of the supposed novelties in the author's herbarium, than as descriptions available for botanical purposes. This should be

carefully borne in mind by those using the systematic portion of the work, the great merit of which resides not only in the information it contains on the subjects mentioned above, but also in the laborious accumulation of valuable and curious matter relative to the medicinal, economical, and other vegetable products of India, and to their history and literature.

The volume of Messrs. Cambessèdes and Decaisne, on some of the plants of Jacquemont's voyage, is (with the exception of Mr. Griffith's papers, to be mentioned in connection with his distributed herbarium,) the only remaining one of any importance relating to Indian plants generally, that has been published since the Prodromus of Wight and Arnott. This, a quarto work, with 180 beautifully executed plates of Indian plants collected by M. Jacquemont, was published at Paris in 1844. The authors, not having access either to the Wallichian or Roylean herbarium, have published as new, many plants well known in this country, but the descriptions and plates are of great value and botanical merit.

The catalogue of Bombay plants by Mr. Graham, published in 1830, has unfortunately been of little use to us, the absence of descriptions rendering it impossible to identify in a satisfactory manner the species referred to. In a thoroughly explored country, the plants of which are accurately determined, such catalogues are of great value; but where the flora is only partially known, and imperfectly described, they are not to be depended on. In the present instance, internal evidence occasionally enables us to recognize with certainty the plant named; but more frequently it shows that the identification is erroneous, without affording that clue which a description would have given, for the rectification of the error. This is the more to be regretted, as Mr. Graham was, we believe, a botanist of great promise, quite able to have determined with accuracy the plants of the regions he explored. The work contains a few descriptions, chiefly from the pen of Mr. Nimmo, upon whom the superintendence of the work devolved, on the sudden death of its author during its printing.

Moon's catalogue of the plants of Ceylon is also a bare list of names. Many of these are evidently erroneously applied, so that it is impossible to make use of them. Fortunately, however, this is of little consequence, as we have no lack of specimens from Ceylon. Moon's collections were excellent; but he does not appear to have sent any specimens to Europe.

Dr. Voigt's 'Hortus Suburbanus Calcuttensis,' published at Calcutta in 1845, is, for the same reason, not available as a work of reference, nor can we refrain from expressing our regret that talents of so high an order should have been devoted to a work of so little practical use.

Dr. Lindley's invaluable 'Genera and Species of Orchideous Plants' contains descriptions of all the Indian Orchideæ collected by Wallich and his predecessors; and in the published parts of the 'Folia Orchidacea' (now in course of publication) we have a complete account of many of the genera, drawn up after a most laborious and critical examination of all the materials accessible up to the latest day. Our own collections are being thus published, and we consider ourselves highly fortunate in their falling into such able hands*. Dr. Lindley has further rendered essential service to Indian botany by numerous descriptions and figures of Indian plants that have appeared in various illustrated periodicals. He laboured indefatigably in the distribution of the great Wallichian Herbarium; his elementary books on botany, and his great work, the 'Vegetable Kingdom,' are indispensable both to botanical students and to proficients; whilst, by the scientific direction he has given to the study and practice of horticulture, as an author and as secretary of the Horticultural Society of London, he has been the means of rendering English botanists familiar with the plants of India in a living state, to an extent that would have been thought visionary a few years ago.

* The analysis of plants of this Order, in a dried state, is a work of the utmost difficulty; and we would urge upon botanists in India the necessity of drawing and describing the fresh specimens, and of preserving the flowers (as of all plants whose parts are injured by the operation of pressing and drying) in spirits or acid.

While the botany of continental India has advanced thus rapidly, equal progress has been made in the Dutch possessions by the indefatigable exertions of a succession of distinguished botanists. One of the earliest in the field, though the extent of his labours is unfortunately but little known, was Dr. Horsfield, whose researches in Java and the neighbouring islands began in 1802, and were continued till 1819. During that time he collected upwards of two thousand species, the most curious and interesting of which have been published by Messrs. Brown and Bennett, in the 'Plantæ Javanicæ rariores,' one of the most profound and accurate botanical works of the day, and one most important for the Indian botanist to study with attention.

Professor Blume, whose extraordinary labours have long since placed him at the head of Malayan botanists, was originally a student of medicine and zoology, and directed his attention to botany in the prosecution of his pharmaceutical studies. The remarkable novelty and curious forms of vegetation with which he was surrounded in Java, effectually diverted his attention from his original pursuits; and he undertook a botanical tour in that island in 1823, 1824, provided with an unusually large staff of collectors and artists; and in 1825 he commenced the 'Bijdragen tot de Flora van Nederlandsch Indie,' an octavo work, containing descriptions of an immense number of new genera and species of Javanese and other insular plants. Though very incomplete in its scope, and written in great ignorance of the labours of others, and of the necessity of detailed descriptions, this is in many respects a remarkable book, evincing a capacity for scientific botany, such as has been displayed by few at so early an age and under so great disadvantages.

On his return to Holland, Professor Blume commenced his magnificent publications on the plants of Java and others of the Malayan Islands, all of which are indispensable to the Indian botanist; very many species, and nearly all the genera of these islands, being also common to the Malayan

peninsula and Eastern Bengal. The 'Flora Javæ' was commenced in 1828, and the 'Rumphia' in 1835, each of which consists of several folio volumes, illustrated with a profusion of admirable coloured plates, in many cases accompanied by anatomical details of rare excellence; these are amongst the most splendid and learned botanical works of the age, and have placed their author high in the rank of botanists. In them many of the defective parts of the Bijdragen are worked up and illustrated, and in the 'Museum Botanicum Lugduno-Batavum,' an octavo periodical, with outline plates, containing admirable analyses, commenced in 1852, we have careful descriptions of more of these, and of still other genera and species of Java, Borneo, Molucca, and Japan plants.

The Museum at Leyden is a rich store of botanical materials, which have been accumulating for many years from all the Dutch possessions in the east and west; and it is exceedingly to be regretted, for the sake of science, and the honour of the Dutch Government, which has patronized botany to an extent unsurpassed by any other country, that the enormous piles of duplicates which they possess should be withheld from the scientific institutions of Europe and America.

The beautiful folio volume of M. Korthals, 'Kruidkunde,' or Botany of the Dutch East Indian possessions, is another monument of the munificence of the Dutch Government. It contains seventy coloured plates, illustrating, amongst other natural orders, that of Nepenthaceæ.

The botanical Professors De Vriese, of Leyden, and Miquel of Amsterdam, have laboured long and successfully in Indian botany, and we owe to their industry and energy many important memoirs; and to their liberality most valuable herbaria, procured in some instances at their own cost. M. Miquel's monographs of the difficult orders Piperaceæ and Fici are standard works of essential service to us as Indian botanists, though we do not concur in the author's limitations of genera. M. Miquel has also named the Canara and Nilghiri collections distributed by Hohenacker; but any approach to

accuracy in the determination of the known species and discrimination of those which are new, was obviously impossible without a considerable general knowledge of Indian botany, and a comparison with English herbaria, of which Dr. Miquel had not the opportunity of availing himself.

M. De Vriese's labours include various memoirs on Malayan Island plants; and his recent monograph of *Marattiaceæ* is a work of great labour, but his views of the limits of species are wholly at variance with our experience.

Hasskarl, the author of the 'Hortus Bogoriensis' a catalogue (with occasional notes and descriptions of new species) of the plants cultivated in the Government Botanical Garden of Buitenzorg, near Batavia (published in Batavia in 1844), is also author of an octavo volume of descriptions, entitled 'Plantæ Javanicæ rariores' (Berlin, 1848).

The 'Reliquiæ Hænkianæ,' of Presl, is a folio volume with plates, devoted to the materials collected by Hænke, who was employed in the Spanish service, and collected in America and Manilla; the Indian plants described are few, and the descriptions and identifications far from satisfactory.

The 'Flora de Filipinas' of Father Blanco, published at Manilla in 1837, is a botanical curiosity, written in Spanish. The descriptions are intelligible, but, from the author's want of acquaintance with scientific works, so many well known plants are treated as new, that we consider it undesirable to devote time to their identification.

Turning to the west of India, we find ourselves treading upon the limits of other floras, that have been more or less perfectly elucidated, in works which we have constantly quoted in the Flora Indica: of these, the most important are the writings of Ledebour, especially the 'Flora Rossica,' 'Flora Altaica,' and 'Icones Floræ Rossicæ.' The 'Flora Rossica' contains descriptions of the plants of the whole Russian dominions, which may be said to be very satisfactorily explored, botanically, especially considering their enormous area. The majority of our Afghan and Tibetan plants, being also natives

respectively of the Caspian steppes and North Persia on the one hand, and of Siberia on the other, have been described by Russian botanists, and especially by Ledebour, Bunge, Turczaninow, C. A. Meyer, and Fischer, besides being rendered classical by the labours of Gmelin and Pallas.

Boissier's 'Diagnóses Plantarum Orientalium,' published in the 'Annales des Sciences Naturelles,' contain descriptions of many new Persian and Levantine plants, mainly from the collections of Kotschy and Aucher-Eloy, which are also common to Western Tibet, Afghanistan, Sind, and Beluchistan. We have largely availed ourselves of the excellent descriptions in these diagnoses, though differing from their truly learned author in his estimate of the influence of climate and the effects of variation. M. Boissier's knowledge of the South European and Mediterranean flora is, we believe, unrivalled, and derived from personal experience acquired during several years spent in exploring indefatigably the Spanish, Grecian, and Oriental floras, of which we have numerous representatives in India, and we therefore record our dissent from the views of so great a botanist, on the limits of species especially, with the most sincere respect, and with considerable diffidence.

It would be out of place here to enumerate the European and Mediterranean Floras of which we have made daily use; there are few of them that we have not been obliged to consult, especially with reference to the critical discrimination of plants belonging to such genera as *Ranunculus, Delphinium, Aconitum*, etc., etc. So many of these floras are mere compilations, or made up of local varieties ranked as species, or studies of the plants of particular areas, treated of without reference to their value as members of the vegetable kingdom, that we find ourselves, when studying any of the large European genera, plunged into a maze of difficulties, to extricate ourselves from which it has been necessary to work out each species *ab initio*, and from a study of all its forms. Koch's 'Flora Germanica' for descriptions, and Reichenbach's 'Icones' for illustrations, are both accurate and useful; and in Vivi-

ani's 'Flora of Dalmatia' we have an excellent systematic and descriptive work, displaying enlarged views of the limits of genera and species.

It remains to allude to the labours of writers on American botany, to whom we have been indebted in an unusually great degree, considering the remoteness of that country from India. Of these, the 'Flora Boreali-Americana' of Sir William Hooker, and the unfinished 'Flora of North America,' by Torrey and Gray, are books of standard excellence: the plants described in both these great works having been critically compared with European specimens, their authors have been enâbled to throw great light upon their distribution, limits, and variations, of which, however, European botanists have been slow to take advantage. Gray's 'Flora of the Northern United States' is another excellent systematic work; and the 'Illustrations of the Genera of North American Plants,' by the same admirable botanist, is one of the most able and philosophical works in the whole range of botanical literature, and one to which we have been largely indebted.

B. *Enumeration of Herbaria.*

We now proceed to enumerate the materials which we have at our disposal in the preparation of the Flora Indica. It is not possible at present to estimate with accuracy the number of species contained in each individual herbarium, as a critical examination of every one would be necessary for that purpose. We have, however, endeavoured to approximate to a correct estimate.

1. The great Wallichian Herbarium, the history of which is well known to all botanists, having been given in detail in the lithographed list of its contents, which was distributed with it, also in the 'Plantæ Asiaticæ Rariores,' and in the introduction to Wight and Arnott's Prodromus. The first set of this truly valuable collection was presented by the East India Company to the Linnean Society of London, in whose

apartments it is preserved. As all the duplicates were made up into sets, ticketed, and distributed at home and abroad, this herbarium has taken the place of a standard work of reference, and it is impossible to over-estimate its value, or the importance of the constant access which we have enjoyed to its contents. The numbers attached to each plant have been so cited by all monographists, that a reference to these, in the great majority of instances, suffices for the identification of the species; and we have therefore constantly quoted the catalogue numbers, carefully examining every specimen before doing so, in order to avoid as much as possible the risk of error. The distribution appears on the whole to have been made with much care, though the limited time allotted to its execution prevented that critical comparison without which species of difficult genera cannot be discriminated. Hence we occasionally find two or more species under the same number and letter, and far more frequently the same species under two or more numbers. It is not easy to say how many species are contained in the Wallichian collection; but the 9000 numbers may, we think, be diminished by at least one-fourth, as Dr. Wallich, being obliged to distribute without describing, very judiciously avoided uniting apparently distinct forms. For the present therefore we estimate this great collection at between 6500 and 7000 species. The named specimens of this Herbarium having been, as we have said, extensively distributed, it has been customary with botanists to retain the names given by Dr. Wallich. We have been careful to do the same ourselves for all otherwise unpublished genera and species; but where published names, accompanied with descriptions, have come in contact with them, we have considered it to be our duty to follow the generally recognized rule of priority, and to retain the published one; except, of course, in cases where the authors of these names had habitually availed themselves of the Wallichian collections, and where we feel justified in assuming that they would wish to have adopted the Wallichian name had they recognized the plant.

2. In the herbarium of the British Museum there are several small collections, which are of great importance to the Indian botanist, especially one containing many of Loureiro's plants, which are not readily recognizable, at all events as to species, by the descriptions in the 'Flora Cochinchinensis.' There are also a considerable number of specimens forwarded to Sir Joseph Banks by Roxburgh, Hamilton, and Russell, which are occasionally of use in determining the species described by Roxburgh. It contains also a fair but not a full set of the Wallichian herbarium. The British Museum also contains König's collections and manuscripts, Kämpfer's Japan and other plants, and Hermann's herbarium.

3. Dr. Wight's earlier collections, which were distributed in 1832–3, have been enumerated in detail in the 'Prodromus Floræ Peninsulæ,' and have been in part described in that work. Dr. Wight went back to India in 1834, and has, as we have already said, devoted prodigious zeal and energy to the advancement of Indian botany; he returned to England in 1853, with enormous collections, chiefly from the mountainous parts of Southern India. To these we have been allowed the freest access; and though the mass of duplicates is as yet only partially unpacked, an admirably selected set of specimens has enabled us to determine with accuracy all his species.

4. The collections of Mr. Griffith were made in various parts of India. Their contents may be known by a reference to his posthumous notes and journals, published in Calcutta under the auspices of the Indian Government; in general terms they include collections from Malacca, Tenasserim, the Khasia Mountains, and the whole Assam Valley, Mishmi and Naga hills and the upper Irawadi, Calcutta, Bhotan, Simla, Sind, and Afghanistan. It is unfortunate that these fine herbaria should have been distributed promiscuously, without any determinate plan, and without any reference to his published notes and journals, which robs the collections of half their value, and the journals of more than half theirs. This is the more to be regretted, as Mr. Griffith's collections

were not always made with a view to extensive distribution, and he frequently could not pay the necessary attention to the preservation of specimens in a fit state for future examination, devoting his time mainly to making notes, which are of extreme value, and to a certain extent obviated the necessity of many specimens. Of these collections we believe one and the only complete set is in Calcutta, and was retained for Mr. Griffith's private use, as containing the manuscript numbers referred to in the journals; the specimens were small and poor. It is of the utmost importance that this should be transmitted to England and deposited in some safe quarter for public access. The total number of species collected by Griffith is probably not under 9000, which is by far the largest number ever obtained by individual exertions. Amongst the distribution of his miscellaneous collections were three conspicuous ones:—

a. Malacca, Tenasserim, and Afghanistan plants, distributed numbered by himself. The best sets of these went to the late Dr. Lemann, and the majority will form part of the Cambridge University Herbarium; the Afghan ones were transferred, previous to Dr. Lemann's decease, to Mr. Bentham, and are incorporated with that botanist's extensive and admirably-named herbarium. The second sets were communicated by Mr. Griffith to Sir William Hooker's herbarium. Others were sent to Dr. Gardner of Ceylon, and Dr. Wight of Madras. Of these, Gardner's were sold at his death, when Sir William Hooker purchased the Malacca specimens.

b. A distribution, through the late Dr. Lemann, of Khasia and Assam collections; of these, some were formed by Mr. Griffith, at his own expense, and others, we believe, formed part of the Assam Tea Deputation collections, and were due to the joint labours of Dr. Wallich and himself.

c. More lately there has been a distribution of Khasia, Bhotan, Mishmi, Assam, and Calcutta garden specimens, and of miscellaneous Palms, under the direction of the East India Company.

d. An immense collection of Ferns sent to Sir William Hooker by Mr. Griffith.

We believe that some of this lamented botanist's collections still remain in the vaults of the India House, but their contents are unknown to us; perhaps they contain the Irawadi collections, and those of Tenasserim and Martaban, which are a great desideratum to science.

Now that we are on the subject of Mr. Griffith's botanical labours, we feel it incumbent upon us to record our sincere regret at not being able to quote regularly the posthumously-published drawings and observations of that indefatigable naturalist. It is well known that these manuscripts were not left in a fit state for publication, and that to have edited them properly, required a very able and careful botanist, well versed in the Indian flora especially. It is a most unfortunate circumstance for the fame of Griffith, and the credit of all parties concerned, that what has been published is not available for the purposes of science. Even in the folio volume on the Palms of British East India, the materials for which were left in a tolerably perfect state, the errors of all kinds are so numerous and involved, that it cannot be consulted without the greatest caution; and, as we have said above, the specimens distributed, whether by Mr. Griffith or the East India Company, not bearing the numbers of his printed catalogue, we have, in an overwhelming number of instances, no means of identifying his plants with his notes of their locality, habit, etc., except in the rare instances where the brief descriptions contained in his 'Itinerary Notes' enable us to do so. Our own opinion of Mr. Griffith's exertions and botanical attainments is, that he has never been surpassed in India; and we wish all the more to give publicity to this opinion, because the circumstances alluded to prevent that repeated acknowledgment of the value of his writings, which would have appeared everywhere in our work, had his own been so edited as to render this possible. We cannot conclude this notice of his labours, without a regret that he was not spared, both to edit

his own manuscripts, and to publish what he so often mentions to be the great ultimatum of his labours, an accurate and philosophical Flora Indiæ. For such a task he had no rival, and he justly appreciated, in common with all botanists, the paramount importance of such a work, (already far too long delayed, considering the present state of the science,) not only as being absolutely necessary to ensure further sound progress, but as the only means of checking that hasty publication of Indian plants from imperfect materials, which has now thrown the Indian Flora into so great confusion.

5. The Parisian Herbarium at the Jardin de Plantes possesses the valuable collections of the indefatigable Jacquemont, whose premature death deprived botany of an ardent and enlightened votary, whose labours would have done much to advance the science. M. Jacquemont's collections were made partly in the Gangetic plain, but mainly in the northwest Himalaya, a great part of which was first explored by him. He entered the mountains at Massúri, and explored Garhwal and Sirmur, and ascended the Satlej into Kanawer and the Tibetan province of Piti. Returning thence to the plains, he visited Lahore and the Salt-range of the western Punjab, and travelled by Jelam and Bhimbar to Kashmir. In this (at that time) unexplored province of the Himalaya he spent a whole summer, and accumulated rich collections. Leaving the mountains, he travelled through Delhi, Ajmir, and Nimach, across Malwah to Bombay, whence he went to Púnah, on the eastern slope of the range of the Ghats, and there succumbed under repeated attacks of liver-complaint, brought on by hardship and reckless exposure in the pursuit of his favourite science.

The journals of Jacquemont, which were published by the French Government, bear ample testimony to his great botanical attainments. He was evidently deeply impressed with the importance of careful observations in geographical botany, and noted with the utmost care the localities of his plants. Had he lived to work out the result of his own labours, Hi-

malayan botany would have long ago been established on a foundation of judiciously collected facts; but unfortunately his journals, though sufficient to show the ample means at his disposal, were not thrown into a shape in which they are available to science, nor would it have been possible to give them such a form without the local knowledge which was lost with their collector. Other botanists have since traversed the scenes of M. Jacquemont's labours, and, more fortunate than he, have been enabled to reap the well-earned reward of their exertions; but let it not be forgotten that a foreigner was the first in the field, and but for his lamented decease, would have stood in the very foremost rank of Indian botanists. We are proud to say that the Directors of the Jardin de Plantes (through M. Decaisne's good offices) have been so liberal as to place at our disposal a nearly complete set of these truly valuable collections, which are accurately ticketed, so that the exact localities are in almost every case easily determined. Our acquaintance with many of the districts where Jacquemont travelled, will enable us to make the best use of this valuable gift, and to give to his discoveries their well-merited precedence.

6. Dr. Royle's extensive collections of Northern Indian and Himalayan plants, formed the groundwork of his work already noticed. A detailed account of the districts investigated by Dr. Royle, and by his collectors, will be found in the introduction to that work. These were chiefly the Jumno-Gangetic Doab, the upper part of the Gangetic plain, and the mountains of Garhwal, Sirmur, Kanawer, and Kashmir. By continental authors, Dr. Royle's Himalayan plants are occasionally quoted as from Nipal, a mistake which leads to erroneous conclusions, and which therefore requires to be guarded against. The original set of Dr. Royle's collections remains in his own possession, and he has liberally placed it at our disposal for examination and comparison with our own. As the specimens are named in accordance with his work, we have been able in every case to identify them. Dr. Royle

presented to the Linnean Society a similar named set, as complete as possible, together with all his duplicates, for the purpose of distribution: his intentions in this matter have, however, unfortunately not yet been carried into effect.

7. Besides the herbaria of Wallich and Royle, the Linnean Society possesses several very valuable collections of Indian plants, which have been of great service to us. These are—1. An authentic collection of Roxburgh's plants, for the most part named. The names are chiefly Roxburgh's earlier ones, but they are in all cases identifiable with those of his Flora Indica, by means of the coloured drawings at the India House, of which copies made by Sir William Hooker, as related in detail in Wight and Arnott's Prodromus, are at our disposal. With these means of determining Roxburgh's plants, we trust that few, if any, of those contained in the orders which we have investigated will remain in obscurity. Several species not hitherto recognized either by Wallich, or by Wight and Arnott, will be found in the first part of our Flora, and the number may be expected to be increased. 2. A large collection of plants of the Bombay Presidency, chiefly from the neighbourhood of Punah, presented by Colonel Sykes to the Society. These amount to nearly a thousand species, and the specimens, though often indifferent and much injured by insects, are, in general, capable of determination. 3. The Smithian Herbarium contains a good many specimens from Hamilton and others, and is valuable as a means of determining the species described by Sir J. Smith in Rees' Cyclopædia and in the 'Exotic Botany,' where he has occasionally indicated new Indian plants. It is almost superfluous to add, that the Linnean Herbarium is the gem of the Society's possessions.

8. The collection distributed by Captain Strachey and Mr. Winterbottom consists chiefly of the plants of Kumaon and Garhwal, and of those of the adjacent parts of Tibet. Captain Richard Strachey was appointed by the Indian Government to make a scientific survey of the province of Kumaon, and

was occupied on the task about two years, during which time, in addition to the important investigations in physical science which occupied his attention, he thoroughly explored the flora of the province, carefully noting the range of each species. He was joined by Mr. Winterbottom in 1848, and they travelled together in Tibet. Their joint collections, amounting to 2000 species, were distributed, in 1852–3, to the Hookerian Herbarium, the British Museum, the Linnean Society, and some foreign museums; and the scientific results are now in course of publication. The beautiful preservation of the specimens, and the fullness and accuracy with which they are ticketed, render this herbarium the most valuable for its size that has ever been distributed from India; and we beg here to record our sense of the great benefit that has been rendered to botanical science by the disinterested labours of these indefatigable and accomplished collectors.

9. The herbarium of Dr. Arnott at Glasgow is particularly rich in Indian plants, and especially valuable as containing the materials from which the 'Prodromus Floræ Peninsulæ' was elaborated. Its distance has prevented our having it in our power to consult it regularly, but Dr. Arnott has been good enough to afford us his assistance in making comparisons in every case of difficulty. This has been to us a most material benefit, as we have not hesitated to apply to him in all doubtful points.

10. The extensive herbarium of Mr. Bentham, our greatest descriptive botanist, has in like manner been readily accessible to us by the kindness of its owner*. In addition to its value as an authentically-named collection,—in which respect it is, we believe, in proportion to its size, quite unrivalled,—this herbarium contains a number of important contributions from Indian botanists. We have consulted it for the orders included in the present part, and hope to continue to do so in

* Whilst these pages have been passing through the press, Mr. Bentham's Herbarium has become the property of the Royal Gardens at Kew, through the disinterested liberality of its owner.

all cases in future. Mr. Bentham has also been good enough to entrust to us his complete set of Mr. Edgeworth's plants, which are authentically named by that gentleman, and correspond with his paper on North Indian plants in the twentieth volume of the Transactions of the Linnean Society of London. We have thus had it in our power to quote the synonyms of that memoir with confidence. The benefits which we have derived from Mr. Bentham's profound knowledge and ready help, and the obligations we are under to him, are such as it is impossible adequately to express.

11. We have in like manner to thank Dr. Lindley for his generous assistance in every way, and for unlimited access to his valuable collection, which has enabled us to identify many of the species described in the 'Botanical Register,' the 'Journal of the Horticultural Society,' and other works of this excellent botanist. Dr. Lindley's herbarium contains a fine set of Penang plants, communicated by Mr. Prince, and by Mr. Phillips; and numerous specimens from Ceylon collected by Mr. Macrae.

12. The Indian collection of Colonel Munro, 39th Regiment, has also, by the liberality of its owner, been placed at our disposal. Colonel Munro's earlier collections were made in the Madras Presidency, but after his removal to Bengal he explored the vicinity of Agra, and made an extensive tour in the Himalaya from Kumaon to Simla and Kanawer.

We cannot conclude this comprehensive catalogue without an allusion to the labours of Dr. Falconer, one of the most estimable, able, and accomplished of Indian botanists; to whose liberality and good offices we were in many ways indebted as travellers in India, and are still, as workers at home. Dr. Falconer was one of the first botanists who visited Kashmir and Little Tibet, where he formed magnificent collections, as he also did in Kumaon and the Punjab, illustrating his specimens with voluminous notes and details of their structure and affinities. His collections are, we believe, still in the India House, where they have been for many years. They consti-

tute the only herbarium of importance to which we have failed to procure access, and we are hence unable to do our friend that justice in the body of this work, to which, as the discoverer of many of the plants described, he is pre-eminently entitled.

13. The only other extensive collection in Great Britain is the Hookerian Herbarium, in which our work is carried on. This is beyond all doubt both the richest and best-named herbarium in the world, and it possesses the rare advantage of containing an extensive series of specimens of each species from many countries and collectors, so preserved and arranged that all may be brought at one time under inspection. For these reasons (and from the extreme liberality of its owner) the Hookerian Herbarium has been studied by most monographists at home and abroad, and possesses in consequence an enormous proportion of authentically-named specimens, by Arnott, Asa Gray, Bentham, Boott, Choisy, Decaisne, De Vriese, Grisebach, Herbert, Lehmann, Liebmann, Lindley, Meisner, Miers, Miquel, Moquin-Tandon, Meyer, Munro, Nees von Esenbeck, etc. etc., and illustrates the published works of these and many other botanists, to an extent that no other herbarium does. It is also enriched with many valuable manuscript notes, dissections, sketches, and remarks by its possessor, and by M. Planchon, who was for some years its curator. It would be out of place here to give a history of the rise and progress of the Hookerian Herbarium, or of the sources from which it is mainly derived; though this would form a most interesting contribution to the literature of the science, and would include a history of the progress of systematic and descriptive botany during the last half-century. It is especially rich in Indian plants; and an enumeration of these, which is necessary, as they constitute a large part of our materials, will give the reader an idea of the nature of the abundant sources from which its riches are derived. The Indian portion of the Hookerian Herbarium comprises the undermentioned collections.

1. A good set of the Wallichian Herbarium, and some collections communicated by Dr. Wallich from Nipal, previous to his first visit to England.

2. Dr. Wight's Peninsular collections, distributed in 1832–33.

3. General and Mrs. Walker's very extensive Ceylon collections, and a smaller herbarium from Simla.

4. Dr. Gardner's Ceylon and Nilghiri plants, both numerous and good.

5. Major Champion's Ceylon plants, presented by him in 1852, along with his whole Herbarium.

6. Large collections of Ceylon plants from Mr. Thwaites. These are in course of publication by that botanist, who succeeded Mr. Gardner as superintendent of the Botanic Gardens of Peradenia, and who is now actively and ably investigating the flora of the island.

7. Mr. Griffith's Malacca, Tenasserim, Khasia, Assam, Mishmi, Bhotan, and Afghan plants.

8. Hohenacker's Nilghiri, Kurg, and Canara plants, collected by the Rev. Mr. Schmid and others, and named by Professor Miquel.

9. Admiral Sir Frederic Adams' Nilghiri plants (a small collection).

10. Sir William Norris's Penang and Malacca plants: an excellent collection.

11. Mr. Prince's Penang plants.

12. Mr. Lobb's Malacca, Tenasserim, Khasia, and Malabar collections. Mr. Lobb collected in the service of Mr. Veitch, the eminent nurseryman of Exeter; his Khasia and Malacca collections are very numerous.

13. Mr. Cuming's Malacca plants.

14. The Rev. Mr. and Mrs. Mack communicated beautiful collections from Assam and the Khasia mountains.

15. Colonel Jenkins' and Mr. Masters' Assam plants. These formed immense collections, made in various parts of the Assam valley, chiefly in the neighbourhood of Gowhatty.

16. Mr. Simon's Assam and Khasia collections consist of numerous and well-preserved specimens.

17. Mr. Law's very valuable and extensive collections from Bombay, Tanna, Dharwar, and Belgaum contain probably about 1500 species.

18. Mr. Dalzell's extensive collections from the southern Concan and Canara, many of which have been published by him in a valuable series of papers printed in the 'London Journal of Botany.'

19. Mr. Gibson's rich herbarium, chiefly collected in the Concan and Dekhan.

20. A few Bombay plants, from Mr. Nimmo.

21. Dr. Stocks's extremely valuable collections from Sind and Beluchistan, amounting to about 1500 species.

22. Captain R. Strachey and Mr. Winterbottom's magnificent herbarium, already described.

23. The Countess of Dalhousie's extensive Simla collection, formed when the late Earl of Dalhousie was Commander-in-Chief. Also, a small Penang collection by the same lady.

24. Major Madden's Simla and Kumaon plants: numerous and excellent specimens.

25. Jacquemont's superb collections already alluded to.

26. Major Vicary's small but very valuable herbarium, containing many scarce plants from Gorakpur, the Punjab, Peshawer, Sind, etc.

27. Mr. Edgeworth's collections made since his return to India in 1847; these contain his Bandelkand plants, and a very complete Multan herbarium; also some of his Himalayan plants published in the Linnean Society's Transactions.

28. Captain Simpson's Simla and Khasia plants, presented by the late Mr. Fielding.

29. Mr. Winterbottom's valuable and beautifully preserved herbarium from Kashmir, Balti, Hasora, and Gilgit: it contains excellent specimens and much novelty.

30. A small miscellaneous collection from Colonel Munro.

31. Dr. Fleming's interesting collection from the Salt-

Range of the Punjab, and another from the Marri hills between the Jelam and the Indus.

32. Mr. Lance's Kashmir and Tibet collections, communicated through Mr. Edgeworth.

33. Dr. Jameson's collections from Massuri and the Saharanpur Gardens.

As, however, we are so largely indebted to the floras of countries bordering upon India for the elucidation of our Flora, it is necessary to add that the Hookerian Herbarium is as rich in proportion in the plants of surrounding countries as it is in Indian. Of these, the most important are the following:—

A. From the Malayan Archipelago and China.

1. Cuming's magnificent Philippine Island collections, containing about 3000 species.

2. Lobb's Java, Borneo, and Philippine plants, which are very numerous and in excellent preservation.

3. Extensive Javanese collections, communicated by Professors De Vriese and Miquel.

4. Zollinger's Javanese plants.

5. Spanoghe's plants from Java and Timor (not numerous).

6. Professor Blume has communicated authentically-named specimens of a very few Javanese and Molucca natural orders: these are extremely valuable, especially the *Anonaceæ* and *Cupuliferæ*.

7. Mr. Motley's extensive Borneo collections.

8. Mr. Lowe's small collection from the same island.

9. Dr. Seemann's Malayan and Chinese collections.

10. Major Champion's Hongkong herbarium, which has been described by Mr. Bentham in the 'Florula Hongkongensis' in Hooker's Kew Journal.

11. Mr. Millett's Macao plants.

12. The Rev. Mr. Vachell's Chinese collections.

13. Captain Beechey's plants from China, collected by Messrs. Lay and Collie, and described in the 'Botany of Beechey's Voyage.'

14. Mr. Fortune's Chinese collections.

B. From countries to the west and north of India.

1. Very complete collections made by Russian botanists in Siberia, the Altai, North China, Dahuria, and indeed in the whole of the Russian possessions in Asia, chiefly from Ledebour, Prescott, Bunge, Turczaninow, Fischer, Meyer, etc. etc.

2. Karelin and Kirilow's Soongarian and Alatau plants.

3. Szovitz's North Persian and Caspian plants.

4. Aucher-Eloy's complete collections from various parts of Persia, Asia Minor, Arabia, and the Levant.

5. Colonel Chesney's Euphrates plants.

6. Mr. Loftus's small collection from Assyria.

7. Kotschy's very extensive and beautiful North and South Persian collections, chiefly named by M. Boissier, and hence of very great value.

8. Asia Minor and Kurdistan plants from various collectors.

To these very ample materials already existing in this country have to be added our own collections, which we estimate at about 8000 species (including Cryptogamic plants), and an immense number of duplicates. Many of the species were gathered in numerous localities, so that we have it in our power to compare specimens from a great diversity of climates and soils. They may be divided into five groups:—

1. Dr. Thomson's collections made in the plains of North-west India, between 1842 and 1847, chiefly in Rohilkand, Lodiana, and the Punjab, which amount to about 1000 species.

2. Dr. Thomson's Himalayan collections, partly collected in Kumaon and Garhwal during short visits to these provinces in 1844 and 1845, but mainly consisting of the herbarium collected during a Government mission in the north-west Himalaya and Tibet, in 1847, 1848, 1849, in the course of which he visited, in 1847, Simla, Kanawer, Piti; and in 1848 Kashmir and the Panjab Himalaya, Ladak, and the Karakoram Pass. The summer of 1849 he spent at Simla and Ladak. These amount to rather more than 2500 species.

3. Dr. Hooker's collections, made during a botanical mission to India in the years 1848, 1849, 1850, under the auspices of the Commissioners of Woods and Forests. Starting from Calcutta, Dr. Hooker proceeded first to Behar, ascended the Soane valley and crossed the Kymor range to Mirzapur, descended the Ganges, and proceeded to Sikkim. The collections made in Behar and the Gangetic valley amount to about 1000 species. Dr. Hooker spent the summer of 1848 and the greater part of 1849 in the Sikkim and the East Nipal Himalaya, during which he botanized the whole country from the plains to the Tibetan frontier, and accumulated an herbarium of 3500 species. In December, 1849, he was joined by Dr. Thomson at Dorjiling, and they proceeded together, in May, 1850, to the Khasia hills, where the summer was spent: the joint collection amounting to about 3000 species. In November of that year they visited Silhet and Cachar, descended the Megna to the Bay of Bengal, and proceeded to Chittagong, returning by the Sunderbunds to Calcutta, where they embarked for England; this journey yielded about 1000 species.

4. A large herbarium of Peninsular plants formed by Dr. Thomson's brother, the late Gideon Thomson, of Madras, mainly by means of collectors. It amounts to nearly 2000 species, gathered partly in the plain of the Carnatic (chiefly in the neighbourhood of Madras), and partly in the Nilghiri and Cúrg mountains, and in the Courtalam hills.

5. Several collections which were liberally presented to us in India. These, though not extensive, were often extremely valuable, being illustrative of little known regions. From Dr. Jameson we received Saharunpur and Massuri plants; from Dr. Fleming a collection from the Salt-range of the Panjab; from Dr. Grant, a small herbarium of Kanawer plants; from Lieutenant Párish, a set of specimens from the hills of Mandi and Kulu (in the Panjab Himalaya); and from Mr. Simons several hundred Assam species.

As all our own materials were selected with a view to future

publication, no pains were spared to render them as perfect an illustration as possible of the flora of their several districts. For this purpose aberrant forms and varieties were carefully collected, and a great many specimens were dried of each species. Great attention was paid to the ticketing of the specimens, so as to certify the locality and elevation from which they were obtained. In Sikkim and the Khasia hills 500 large specimens of wood were cut; and Palms, *Pandani*, Bamboos, tree-ferns, etc., were preserved entire; whilst the flowers and fruits of more than 1000 species were preserved in spirits. Many notes and dissections were also made on the spot; and we have the further assistance of a series of coloured drawings and dissections (of upwards of 1000 species) taken by Dr. Hooker from the live plants, and of a valuable portfolio of upwards of 500 drawings of Sikkim plants, executed at Dorjiling by native artists, under the superintendence and at the expense of our enlightened and lamented friend, the late J. F. Cathcart, Esq. of the Bengal Civil Service, very much in furtherance of our botanical labours. This has been presented to the Kew Museum by the liberality of his surviving sister.

V. *Sketch of the Meteorology of India.*

Climate is an extremely important element in the geographical distribution of plants; and though it is not necessary to dwell at any great length upon the general principles of Meteorology, an outline of these, as they are brought into operation in India, is requisite for the correct understanding of the transitions of vegetation in different parts of that country. The phenomena of climate in a particular area, are well known to depend not only on its latitude, but also on the configuration of its surface and on its position relative to the ocean, upon the direction of the mountain-chains and their elevation above the level of the sea, and upon the course of the winds. Temperature and humidity, the two

grand elements which give the character to the climate, react naturally upon one another, so that it is not easy to determine which is the cause and which the effect.

For all practical purposes we may regard the sun as the sole source of the temperature of the surface of the globe. If the surface of our planet were uniform, the sun's heating power would be directly proportional to his altitude, and the mean temperature would diminish equably in receding from the equator. A variety of circumstances disturb this regular gradation of temperature. These are—1. The more rapid heating and cooling of land than sea, which arises in a great measure from the heat being gradually diffused throughout the ocean (by means of oceanic currents), the hot water from the tropics being thus carried into temperate regions, while the cold water of the Arctic seas occupies its place. Proximity to the ocean, therefore, promotes uniformity of temperature.—2. The elevation of the land above the level of the sea. The sun's heating power is rather augmented at great elevations; but a diminution of temperature at high levels is caused by the rarefaction of the air, and is a consequence of the law according to which, the *specific heat* of the atmosphere increasing inversely with its density, its *sensible heat* becomes absorbed as it expands. As this law is universal, it follows, that when a current of air ascends or descends, its temperature is changed to an amount exactly proportional to the change of level; and it is only when such a current is hotter than the normal temperature of the place whence it ascends, that it is a warm wind at a higher level.—3. The presence or absence of clouds. These intercept the solar rays during the day, and tend to keep the ground cool. During the night, on the contrary, clouds intercept the radiation of the heat accumulated in the earth during the day, and tend to keep the ground warm. A cloudy climate is hence an equable one, having comparatively cool days and warm nights, cool summers and mild winters.

When the sky is clear, the air in contact with the earth becomes warmed by radiation from its heated surface; and

being expanded and made lighter, it immediately ascends, its place being supplied by air from colder regions. Thus, since no two places have the same temperature, and since the temperature constantly changes, even in the same place, the atmosphere is kept in constant motion.

As the amount of aqueous vapour which is capable of remaining suspended in the atmosphere is directly proportional to the temperature, ascending currents of air finally become so cooled that condensation or precipitation takes place; and the nearer to saturation the air is before it begins to ascend, the sooner it will reach a sufficiently low temperature for condensation. We can therefore understand why mountain-chains (which impede the direct course of the currents, and force them to ascend) cause precipitation of the moisture of an atmosphere which has already traversed, without any condensation, a great extent of level country.

The direction of the wind is primarily dependent upon the sun's position, and is a very complex phenomenon, in consequence of the perfect fluidity of the air. On the open sea, at a sufficient distance from land to escape its influences, the trade-winds, owing to the intertropical heat, blow with great regularity towards the equator, or rather towards a point immediately under the sun's position, varying therefore with the season of the year. Their direction is not due north and south, but more or less towards the west. This is in consequence of their retaining the momentum proper to the latitude whence they start, in their advance towards the equator, where the motion of a point on the earth's surface (due to its revolution round its own axis) is a maximum. They therefore lag behind, as it were, and appear to blow from the north-east in the northern hemisphere, and from the south-east in the southern hemisphere. The presence of land interferes with the regularity of the trade-winds; and where it occurs in large masses, it becomes so much more heated than the ocean, that it attracts the aerial currents towards itself, and hence completely changes the direction of the wind.

The whole of Continental India lies north of the equator, and considerably more than half of its area north of the Tropic of Cancer, whose position very nearly corresponds with the base of the peninsula of Hindostan. Proceeding northwards from the tropic, there is no sea nearer than the Arctic Ocean; but as we advance towards the equator the width of the land gradually diminishes both in the Madras and Malayan peninsulas. It may be observed also, that due south of India, the ocean extends without interruption beyond the Antarctic Circle, while to the eastward, not only on the equator but in the southern hemisphere, there is much land. The Eastern Archipelago, from consisting of large islands, separated by belts of sea, possesses a humid and equable climate; but the great continent of Australia, being a vast expanse of low land, becomes enormously heated when the sun is in the southern hemisphere, and presents extremes of climate. To the westward the coast-line of Beluchistan continues somewhat north of the tropic till it enters the Persian Gulf; but the great continent of Arabia advances far within the tropic; while, a little further west, Africa extends, uninterrupted by sea, far into the south temperate zone. From this relative position of land and sea, it is evident that the whole of the rain which falls in India must be derived from the southward or eastward, and that those parts only can be subject to heavy rains, towards which the sea-wind blows.

The maps of the monthly isothermals*, recently published by Dove, enable us to trace with considerable accuracy the periodical changes of temperature throughout India and the neighbouring countries. An inspection of these maps shows us that in January the isothermal lines in the northern hemisphere are nearly parallel to the equator, but that, in the southern, Africa and Australia are preternaturally hot. Till the vernal equinox, the equator of heat (or that line from which the temperature diminishes both towards the north and towards the south) lies south of the terrestrial equator; but

* See Maps of Isothermals appended to this Essay.

after the beginning of April, it advances rapidly into the northern hemisphere, and two defined regions of excessive heat (86° Fahr.) occur, one in Africa, and a smaller one in the peninsula of India. In May and June the equator of heat lies in India considerably north of the tropic, and the two regions of excessive heat, becoming united, extend uninterruptedly from North Africa, across Arabia and Persia, over all India west of the Bay of Bengal. In July, a still hotter area occurs in Nubia and Arabia, and Northern India is very little inferior in temperature, whilst Southern India becomes cooled; the heat throughout India being modified by the accession of the rains. In this month the isotherms in all parts of Asia are much curved, the convexity being towards the north; and the amount of curve increases towards the northern part of the continent.

In August the equator of heat passes through Northern India, which is still occupied by the rapidly contracting region of excessive heat. In September and October the equator of heat advances rapidly towards the south, and in November it has entirely left India, and corresponds almost exactly with the terrestrial equator, while the region of excessive heat lies in the Indian Archipelago over Borneo and New Guinea.

We see therefore that from the vernal to the autumnal equinox a great part of India is preternaturally hot, but that from October to February (inclusive) it is comparatively cool, and at the same time the continents of Africa and Australia become preternaturally hot. During the summer months therefore, or the hot season as it is commonly called in India, the wind blows from the south towards the north, while in the winter or cold season it blows from north to south. At both seasons these directions are often modified by local causes, besides being uniformly affected by the earth's rotation, and by the heating and cooling of the continent.

The monsoons or periodical winds are known in the Indian Ocean, and indeed generally throughout India, by the name of the south-west and north-east monsoon, these being their

directions at sea. At the commencement of the vernal equinox, the south-west monsoon is very local in its character, the heat being greatest over a small region in southern India. At the same time Arabia and the countries east of Persia are much heated, and cause a southerly wind to blow from the ocean west of India, towards Persia and Afghanistan, while an east wind blows up the valley of the Ganges. After April the northern parts of India become much hotter, and the direction of the southerly monsoon is remarkably influenced, as has been well pointed out by Dove, by the great heat of Tibet, Siberia, and Tartary, which, in consequence of their cloudless climate, acquire an almost tropical temperature during the summer months, and attract the currents northwards.

I. *The south-west or summer monsoon.* This, in almost all parts of India, is a sea wind, and is therefore loaded with vapour. On the west coast of the Madras Peninsula it comes in contact with the range of mountains called the Western Ghats, upon which it deposits a great part of its moisture; in its further course it meets with no greater elevation in southern India, the eastern parts of which are comparatively dry. On the coasts of Orissa and Bengal the direction of this wind is more to the north, from the heating of the continent to the north and north-west, and much moisture is deposited on the mountains of these provinces. In northern India the rainy season commences later than in the Peninsula, because it is not till June that the sun acts sufficiently energetically on the Tibetan mountains and the plains of temperate Asia to attract in that direction the full force of the monsoon. This wind, after passing over the plains of Bengal, comes in contact with the Khasia mountains, upon which, and upon the whole chain of the Himalaya, it discharges itself in heavy rains diminishing in amount as we advance westward, with the increasing distance from the sea. At Calcutta the wind, during the whole of the monsoon, from April onwards, blows from the east of south, but after the beginning of August, when the great rain-fall in eastern Bengal has con-

siderably lowered the temperature of that province, (the arid plains of the Panjab, however, remaining excessively heated,) it becomes S.S.E., and in September still more easterly.

In the eastern (Malayan) peninsula it is probable that the direction of this monsoon is nearly from south to north; but more detailed information is required to enable us to understand the precise course of the aerial current in all parts of that Peninsula. At the commencement of the monsoon the wide and open valley of the Irawadi seems to act as a local source of attraction, to which the wind blows from both oceans. At a later season, the elevated temperature of the plain of the Ganges and the Tibetan valley of the Brahmaputra overpowers that influence, and the main atmospheric current flows over the mountains south of Assam and ascends the valleys of both these rivers in a north-westerly direction.

II. *The north-east or winter monsoon.* As a consequence of what we have stated, after the autumnal equinox, the great mass of the Himalaya becomes intensely cold, and the whole of the continent comparatively cool, while the southern hemisphere gets powerfully heated. The north-east monsoon, which results from this distribution of temperature, is the effect of a distant attraction, and therefore blows with great regularity. It is everywhere a land wind, except in the Malayan Peninsula and on the coast of the Carnatic. In Malaya it blows over a great extent of sea, and is therefore very rainy; but in the Carnatic the width of sea is not great, so that the rain-fall, though well marked, is less, and terminates long before the end of the monsoon, probably from the wind acquiring a more directly southerly direction, after the sun has reached the southern tropic.

The current which flows towards the southern hemisphere as the north-east monsoon, is replaced by an upper one which flows northward. It is from this northerly current, which arrives moisture-laden from the southern ocean, that are derived the winter snows of the Himalaya and of the mountains

of Afghanistan, and the winter rains of the lower hills and of the plains at the foot of the mountains. These last are irregular in amount and period, and dependent perhaps on local disturbances of the great current, the causes of which are still obscure and require careful investigation. During the south-west monsoon, a similar return current from Siberia and Tartary probably flows almost uniformly from the northward at a very great elevation, and joins the ascending current from the plains of India.

When the causes and direction of the periodical winds are clearly indicated, there is no difficulty in understanding why it is that in some parts of India the climate is always moist, both monsoons being rainy, while in others one monsoon only is rainy, and in others again there is no rain at any period of the year. The only permanently rainy province is the Malayan peninsula, and the only absolutely arid ones are Sind and the neighbouring deserts of the Panjab. Throughout the greater part of India one monsoon is rainy, and that generally the south-west one, blowing from May or June till the end of September.

The amount of rain varies prodigiously in different parts of India, from almost none to six hundred inches, but the details must be reserved for notice under the several districts. It is very essential to bear in mind that the rain-fall affords no direct criterion of the humidity of any climate, for the atmosphere may be saturated with moisture without any precipitation taking place. The influence upon vegetation of the vapour suspended in the air, and thus brought in contact with every surface of the foliage, is most important, and can only be ascertained by means of daily observations with the hygrometer. This instrument is indeed, generally speaking, of far more importance to the botanist than the thermometer; the distribution of tropical plants especially, in so far as it is influenced by climate, being so by its moisture*.

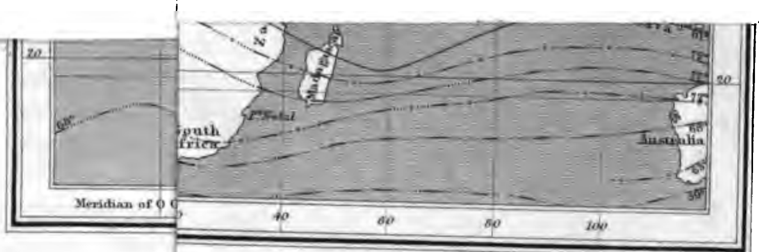
* To make our meaning clearer, we may say that any part of the tropics is hot enough for the growth of a tropical plant, but that whole natural orders,

The normal mean temperature of the equator is stated by Dove to be a very little below 80°, but this is somewhat exceeded in many parts of continental India. The normal mean temperature scarcely diminishes at all between 0° and 10° N. lat. Between 10° and 20° it diminishes 2½°; between 20° and 30°, 7°; and between 30° and 40°, 13·3°. In 20° N. lat. therefore the diminution may be estimated at about half a degree of temperature, and in 30° N. lat. at 1° of temperature, for a degree of latitude. In India, however, the mean temperature does not diminish so rapidly, owing to the increase of the mass of land to the northward, which, as has been shown, becomes excessively heated in summer. The normal difference of temperature between summer and winter is least at the equator, and increases with the latitude; and this effect is enhanced in India by the increase in the mass of land, which makes the summers hotter and the winters colder than the average.

The phenomena of vegetation are less dependent upon the mean temperature of the year than upon that of the season of growth: thus, within the tropics, vegetation is active at all periods of the year, but in the cooler temperate zone, and at considerable elevations on the mountains of the tropics, only during the summer season. It is therefore important in the investigation of climate with regard to its application to botany, to know the mean temperature of each of the four seasons, and, if possible, that of each month.

The only other important element by which climate is affected, is elevation above the level of the sea. The diminution of temperature as we ascend (on the surface of the

genera, and individual species are extremely sensitive to the amount of moisture in the air, and its fluctuations. Some plants are confined to perennial humidity, others to perennial drought, whilst still others are dependent on accessions of heat or drought at certain fixed periods, for life and health or the means of propagation. Comparatively few observations on temperature, and those in certain months only, give us a sufficient approximation to the requirements of a plant in that particular, but the hygrometrical observations should be continued throughout the year.



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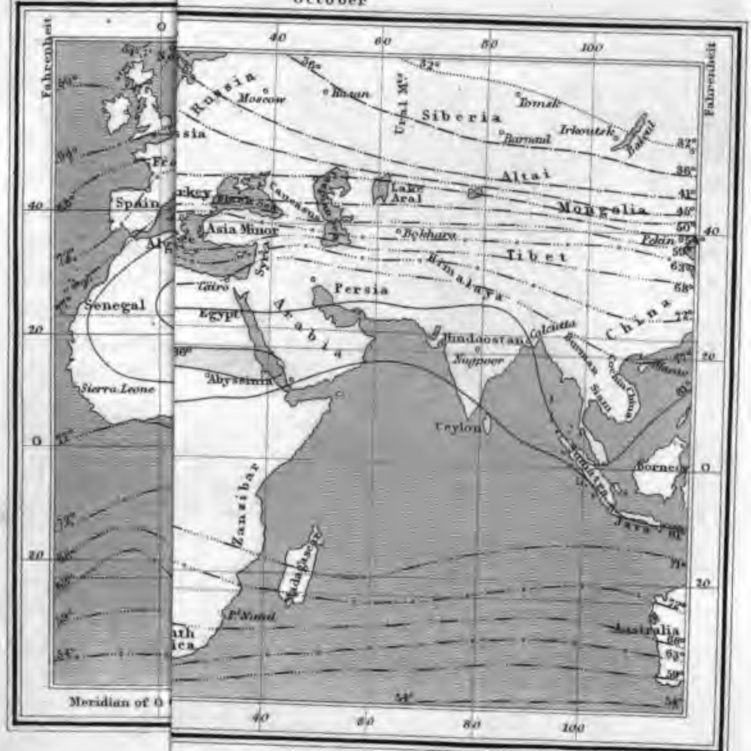

Globe

Engraved by J.& C. Walker

earth) is usually estimated at one degree for three hundred feet. In India, it is only in the most perennially humid and densely wooded mountains, that the diminution of temperature is so rapid as this, for in the drier districts it is very much less. Thus, while in Sikkim 1° for 300 feet is the proportion for elevations below 7000 feet, on the Nilghiri Hills it is about 1° for 340 feet, in Khasia 1° for 380 feet; and the elevations of Nagpur and Ambala produce no perceptible diminution in their mean temperature, which is as great as that which would normally be assigned to them were they at the level of the sea.

When the latitude, the amount of land, the humidity, and the elevation are known, we have every element which influences climate; and as the limits between which each of these elements varies is in India considerable, it is evident that the diversity in the climate of its parts must be very great. We reserve the details of these to the following chapter, and shall confine ourselves here to pointing out the two broad divisions of climates, which it is important to bear in mind, namely, those which are excessive, and those which are equable.

An equable climate prevails in the vicinity of the equator, and in all perennially humid districts; while an excessive climate, in which the summer is very hot and the winter cold, is characteristic of the north-western regions, of the interior of the continent, and of provinces characterized by extreme drought. The northern districts of India are more excessive in climate than the southern, because they are broader expanses of land; and the western side of the great (Madras) peninsula is more equable than the eastern, because it is much more humid.

VI. *Sketch of the Physical Features and Vegetation of the Provinces of India.*

A. *Limits of the 'Flora Indica.'*

Although the main object of this Flora is the illustration

of the Botany of the British Possessions in India, we cannot restrict ourselves to these limits without omitting many important additions made by English naturalists to our knowledge of the Indian Flora; and we have hence, in assigning geographical limits to our labours, been guided as well by circumstances of botanical importance, as by natural and political boundaries. We shall therefore include,—to the north, the whole Himalaya, and as much of Tibet as is known,—to the west, Afghanistan and Beluchistan,—to the east, all the countries to the west of the chain which divides Ava from Siam, and the whole of the Malayan peninsula,—and to the south, the island of Ceylon. It is obviously impossible, even were it necessary, to define these boundaries more rigidly. By including them, we gain a point of the greatest importance botanically, in illustrating the Indian Flora, namely, a very fair representation of the Floras of Egypt, Persia, and Europe, to the west,—of Siberia to the north,—of China to the east,—and of the Malayan Archipelago to the south-east; of the union of the species, genera, or orders of which floras, that of India is mainly composed.

Lest, however, we should be thought too arbitrary in pushing our boundaries so far, we may appropriately introduce here a few remarks on the subject, which will explain our motives more fully. Till very recently, no part of the Himalaya belonged to the British Government, the province of Kumaon (between the Ganges and Kali) alone excepted; but later events have added the whole mountain region between the Ravi and Satlej, and placed the remainder of the North-west Himalaya, including Kashmir, so much under British influence, that an account of its Flora is as essential to botanists in India and Europe, as is that of any of the British possessions. The Tibetan provinces of Ladak and Balti, which continue, as formerly, appanages of Kashmir, have recently been very completely explored botanically by several travellers, whose labours cannot be overlooked, because their herbaria contain many plants which will hereafter be found

within the British boundaries, besides many others which, from being in a different state, or belonging to different varieties of others found elsewhere, are essential for the elucidation of our Flora. For the same reasons we include the Chinese Tibetan district of Guge, immediately north of Kumaon, which has been examined by Captain R. Strachey and Mr. Winterbottom, and whose Flora is identical with that of the British Tibetan valleys of Piti, and of Niti (in Kumaon).

Nipal and Bhotan again are wholly independent states; but to exclude them would be to omit all notice of the splendid labours of Wallich on the one hand (which reflect so much lustre on the liberality of a former Government of India), and of Griffith on the other, who alone has explored Bhotan. Sikkim occupies an intermediate position between Nipal and Bhotan; a considerable part of it belongs to the British, the rest is maintained by our influence and authority; and the whole presents a flora which is not only the best investigated of any district east of Kumaon, but unites the Floras of Nipal, Bhotan, East Tibet, and the Khasia mountains; being hence, in a geographico-botanical point of view, one of the most important provinces in India, if not in all Asia.

Returning to the extreme west, the political boundary of British India lies at no great distance beyond the Indus, but does not include the mountainous regions of Afghanistan, the whole of which was investigated about fifteen years ago by Griffith, who accompanied the army of the Indus on its march from Sind to Candahar and Cabul, and penetrated as far as Bamian and Saighan, forming very large collections. These, besides containing an immense number of Persian and European plants, which find their eastern limits within the British territory, are rich in Himalayan forms which advance no further west, and, what is of still greater importance, they contain many species common both to Europe and the Himalaya, but which, from presenting differences induced by local causes in these two distant countries, might not be imagined to

have had a common origin, did not the Afghanistan specimens blend their characters, or show the transition between them.

The botany of our eastern frontier is less known than that of any other part of India, and, indeed, it is to it alone that we look for any considerable amount of novelty; for though the upper Assam valley and Mishmi hills have been investigated by Griffith, and Lower and Middle Ava by Wallich, their united materials are not extensive; whilst the upper valley of the Irawadi, Manipur, and the other districts east and south of Cachar, are wholly unknown. Griffith, indeed, botanized in the Húkúm valley, but his collections from that country have not hitherto been made available to botanists. The whole of the Malayan Peninsula is also included in our Flora; for though the British settlements of Penang, Malacca, and Singapur, comprise but a small proportion of the peninsula, they may be supposed to represent well the Flora of so narrow a tract of land, whose climate and physical features are almost uniform throughout.

It will thus be seen that the limits of the Flora Indica extend from the 36th parallel of north latitude to the equator, and from about the 62nd to the 105th degree of east longitude; the area of land embraced being little less than two millions of square miles. This is by far the greatest tropical or subtropical area that has ever been made the subject of one Flora; and at the same time it is the most varied, including every climate, from the burning heat and absolute drought of the deserts of Sind, to the humid jungles of the Malayan peninsula, and to the everlasting snows of the Himalaya. Europe, which (to the regret of every botanist) has never been made the subject of one Flora, considerably exceeds India in superficial area, containing three and a half millions of square miles; and it presents several geographical points which afford familiar standards of comparison for distances in India. Thus, the distance in latitude from Ceylon to Tibet is just that from Gibraltar to the Orkneys, or from the Gulf of Finland to the Morea. The greatest breadth of our limits in longitude is from

Cabul to the Irawadi, which is approximately near that from the Bay of Biscay to the Caspian Sea. The extreme breadth of India along a diagonal line is from Cabul to Malacca, and that is also about the extreme diagonal breadth of Europe from Spain to the northern termination of the Ural mountains at the Arctic Sea. We wish to press these comparisons especially upon the attention of local botanists, and of those more familiar with species of plants than with geography, for the following reason,—that on several occasions, having identified a plant of the lower Himalaya with one that inhabits an elevation of 8000 feet in Ceylon, we have been met with expressions of surprise and incredulity, by naturalists who do not for a moment hesitate to unite many species of Scotland with those of a sufficient altitude on the Sierra Nevada in South Spain; who habitually quote the Alps and Pyrenees as containing many species in common with Iceland and Norway, and even Arctic America; and who, whilst acknowledging that many of the elements of the Floras of the Pyrenees, Alps, Carpathians, Ural, Norway, Iceland, and Arctic America are identical, are prepared to deny a similar extension of species over the mountains of Ceylon, the Madras peninsula, Khasia, Himalaya, and Java.

If, on the one hand, we experience opposition to our identifications of species inhabiting localities in India sundered by considerable areas of land and sea, so, on the other, we find equal or greater difficulty in persuading a large class of our fellow-botanists of the specific identity of Indian plants with those of other better known but more distant countries; and we have hence felt anxious on this account also, so to extend the limits of our Flora, that we might meet such botanists on their own ground as it were, and trace these species continuously from those parts of the world with which they are familiar to those we know best. It is, however, impossible altogether to overcome a proneness of the human mind to regard everything from an unknown country, or that is seen surrounded with foreign associations, as itself unknown, and

to banish prejudice from the domain of Systematic Botany as effectually as it has been from some allied sciences, which have fortunately been most successfully cultivated by many men of large experience and extensive attainments in collateral branches of knowledge.

B. *Necessity of dividing India into provinces; and principles according to which it is proposed to be done.*

In order to define with accuracy, and at the same time in an intelligible manner, the geographical range of the individual species comprised within our Flora, it is necessary to divide India into botanical provinces. This we have found a very much more difficult task than might have been supposed, partly from the constantly shifting political and other boundaries of our dominions and its subdivisions, and partly from the necessity of selecting as far as possible such provinces as are defined by physical features rather than by arbitrary lines. We have devoted much time to a careful study of all available information regarding the geography of British India, having had recourse in every case to original documents, in preference to the numerous maps on the physical geography of India published in this country and on the Continent, which have been compiled from these sources, and which, however conspicuous for research, are unexceptionally extremely defective, owing to their authors not having that necessary general acquaintance with the country, which alone could enable them to classify the thousands of facts they have laboriously collected, and which are represented with distorted effect in such maps.

We enter upon our task with a lively sense of our inability to meet the requirements of Botany on the one hand, and of Geography on the other; but it was imperatively necessary that we should, before any part of our Flora went to press, decide upon the geographical divisions to be adopted and the nomenclature to be employed. Though our conjoint

personal experience is very much greater than that of any other naturalists, there are still large areas of the region under consideration, of which we have no personal knowledge whatever: we do not therefore presume to consider our scheme as established beyond the necessity of future modification; on the contrary, we submit it with great diffidence to the criticism of Indian geographers, and earnestly court inquiry into its details.

The physical features of the several provinces will be treated in considerable detail. This seems called for by the general want of accurate information on Indian geography, displayed in many valuable works on various branches of Indian science; and this not only on the Continent, but quite as conspicuously in England. It perhaps arises from the fact that no physicist or naturalist has hitherto proposed such a classified or systematic arrangement of habitats or localities, as may be readily acquired by the professed naturalist; though it should not be forgotten that it is primarily due to the defective state of our education, which leaves otherwise accomplished men so ignorant of the general features of the geography of India, that when the demands of their profession or of science oblige them to study its details, they find insuperable obstacles to their acquisition. At the commencement of this essay it has been observed, that "Ind. Or." is too often the sole indication of the native place of many inestimably valuable vegetable products, even in works of standard authority; and when more detailed localities are given, they are generally copied at random from the tickets of collectors, or the catalogues of local botanists, and are in most cases mis-spelt and equally unintelligible to the resident in Europe and in India. Many botanists indeed seem tacitly to admit that there is a recognized license to overlook both generalities and specialities in treating of Indian plants, and with the honourable exception of Dr. Royle we do not know of one who has written extensively, and not availed himself of this license. Dr. Royle's great aim seems to have

been to break down this system, both by precept and example, and we consequently find his work unique as regards the value of the notices it contains on the geographical distribution of the plants of North-west India; and it is with regret that we see the information he has lavishly given too frequently so distorted in subsequent systematic works, that we have to refer to the original to arrive at the truth. This is certainly from no want of accuracy in Dr. Royle's work, or inappreciation of details, but in some measure to a due prominence not being given to a classified arrangement of the provinces of so extensive and varied a country, and the adoption of such a nomenclature as could be referred to, independently of the other information with which the geographical matter is at present embodied in his writings.

In the scheme we are about to propose, we shall keep the natural divisions (botanical provinces) as large as is consistent with our objects; and in selecting names for them, shall endeavour to choose such as are already familiar to persons conversant with the outlines of Indian geography, studiously avoiding the introduction of any that have not a broader claim to be known and used than mere botanical convenience. Under the description of each province we shall endeavour to communicate as much definite trustworthy information as we can embody, regarding its elevation, the nature of its surface, its climate, etc.; this we have chiefly gleaned from various periodicals and travels, Government reports, and other sources of information, which have come under our notice. In order, however, to avoid much repetition in our descriptions of these provinces, it is necessary to preface our account of them with some general remarks on the geographical distribution of Indian plants.

C. *General Remarks on the Vegetation of India.*

Before proceeding to describe the physical features, etc., of the provinces, we shall give a very short and comprehensive

sketch of the vegetation of India, and of the relation which the Botany of its different great divisions bears to that of neighbouring or distant countries. These remarks, from the incompleteness of the data at our disposal, must necessarily be vague, and may be viewed rather as indications of results likely to be obtained than as absolutely ascertained facts.

We have already said that all the main elements of the Indian Flora exist in surrounding countries, and to this is to be attributed one of the most remarkable botanical features of so extensive an area, namely, the very limited number of peculiar families that are largely represented in it. Thus, *Aurantiaceæ, Dipteraceæ, Balsamineæ, Ebenaceæ, Jasmineæ,* and *Cyrtandraceæ* are the only Orders which are largely developed in India, and sparingly elsewhere; and of these, few contain one hundred Indian species. In this respect the Indian Flora contrasts remarkably with that of Australia, South Africa, or South America, or even with Europe, North Asia, and North America. On the other hand, India contains representatives of almost every natural family on the globe, a very few small South American, Australian, and South African Orders being the chief exceptions; and it contains a more general and complete illustration of the genera of other parts of the world than any other country whatsoever, of equal or even of considerably larger extent. It is hence not surprising that some of the large cosmopolitan families are perhaps less universally preponderant in India than in most other continents, *Compositæ* especially being deficient, as are *Gramineæ* and *Cyperaceæ* in some regions, *Leguminosæ, Labiatæ,* and Ferns in others, whilst *Euphorbiaceæ* and *Scrophulariaceæ* are universally present, and *Orchideæ* appear to form a larger proportion of the Flora of India than of any equally extensive country.

We assume the total number of Indian species included in the limits of our Flora, to be from 12–15,000, but whether this estimate is to be regarded as large or small, comparatively with other parts of the globe, we are not prepared to

say; compared with the exaggerated estimates of the Floras of other tropical countries, which are so frequently put forth, this number (which is certainly not too small) must appear insignificant; nor would it be fair of us to expect credence for it, did we not add that it is the result of the collation of many irrefragable data, after making a large allowance for dubious, undescribed, and even undiscovered species. It is right also to add, that our conviction that the estimates of other Floras (and indeed of the Flora of the whole globe) are excessively exaggerated, is founded upon extensive personal experience, and the careful consideration of a large body of well established facts; and we are emboldened in enforcing it, by the sanction of Mr. Brown, with whom we have repeatedly discussed this curious and extremely important subject.

With regard to the general diffusion of species throughout India, we believe that there is no part of the whole area included in our Flora where a radius of ten miles produces many more than 2000 species of flowering plants, and that this is very rare, confined to mountainous districts, and possibly to the Khasia. It is further probable that a continuous area, with a radius of fifty miles, containing 4000 species, is nowhere to be found in India; if anywhere, its centre is probably in the Assam valley, in which case it would include the Khasia, Jheels of Bengal, and the loftiest regions of the Himalaya.

With regard to local assemblages of species in very narrow areas, these are never very numerous, except in the pastures of the temperate and subalpine districts, where thirty to forty, in different stages of luxuriance, may be found within a radius of six feet. Nearly as many may be gathered in the neighbourhood of, and upon, one moss-covered rock or tree-stump on the damp, exposed hill-tops of the Khasia. It is almost impossible, however, to appreciate the nicely balanced local circumstances that determine the number of species which will all find room, and keep it, in a limited space: much depends on the prevalence of species that combine to check the

full growth of individuals on the one hand, and that exclude gregarious species on the other. In the more humid jungles of the luxuriantly clothed parts of India, a very few species are to be found in close contiguity, but many in a moderately large area. In the drier and hilly districts of Central India we have found it difficult, especially in winter, to collect 150 species in a walk of several miles, and this where there was no apparent want of trees, shrubs, or herbs. On the other hand, during the rains we have, in the Panjab, collected eighty species, chiefly of tropical annuals, in an area of a hundred yards square; these, however, were brought together by local circumstances, and the total Flora of the country for ten miles around the same spot probably comprised less than 800 species. At 4–5000 feet elevation in the Khasia we have collected upwards of fifty species of *Gramineæ* alone, in an eight miles' walk, and twenty to thirty *Orchideæ;* but these are quite exceptional cases.

There is almost a total absence of absolutely local plants in India, at least so far as our experience serves us; but in saying this, we are only giving the result of general impressions, and of comparing the contents of our collections with those of other travellers, and with the statements of trustworthy botanists in Australia and South America.

Before dismissing this branch of our subject, we may mention that the general physiognomy of the greater part of the Indian Flora probably approximates more to that of Tropical Africa than to any other part of the globe, accompanying in both cases immense alluvial plains, bounded by deserts at certain points, and traversed by mountain-chains of moderate elevation. The more loosely timbered drier regions probably assimilate very much to the districts of Senegal, Upper Egypt, and Abyssinia; the west shores of the Madras peninsula, and the whole Malayan peninsula to the tropical African coasts; and the deserts of Sind to those of North Africa.

Besides the absence of great forests, there is in India no representative of the Catingas of Brazil, the Pampas of South

America, the Savannahs of North America, nor of those dry plains studded with hundreds of species of flowering shrubs and bulbous herbs, which are so characteristic of the Cape of Good Hope and of Australia. The plains of India are indeed everywhere extremely poor in species, and such as abound in individuals are usually of a weedy character. The hilly parts of moderate elevation again are far from presenting that gorgeous display of flowers and foliage that the Brazilian forests do. The gaudy *Cacti*, *Amaryllideæ*, *Liliaceæ*, and *Melastomaceæ*, amongst other Orders of that country, have no representatives in India similar in beauty, variety, and abundance. In fact, there are few countries in which the vegetation of the more accessible parts presents so little beauty, or such short seasons of bloom.

Maritime plants, again, are rare in India; nor is there a well-marked and generally diffused littoral Flora; such, we mean, as is composed of plants that are not absolutely seaside, but which never wander many miles from the ocean.

a. *On the Distribution of Indian Plants as influenced by Climate.*

From the position of India, we have seen that its climate (and hence its vegetation) is more generally tropical, than the latitude under which so much of it is included would alone indicate. The mountains, however, when above 4–5000 feet, everywhere present more or less of a temperate vegetation, which becomes wholly temperate at greater elevations, and which passes into an alpine Flora over a large extent of still loftier mountain country.

Within the limits of the strictly tropical region there is the greatest possible difference between the vegetation of the humid and that of the arid climates, shown not only by a difference of species, but of genera and whole natural families, and accompanied by a corresponding dissimilarity in the aspect of the country. Thus, the impenetrable green jungles of the equable and rainy Malayan peninsula, of Eastern

Bengal, the west coast of the Madras peninsula, and of Ceylon, contrast strongly with the drier parts of the intertropical zone, and still more so with the loosely-timbered districts of Central India, and of the base of the western Himalaya. The absolutely sterile deserts are confined to the extensive plains, which are all cut off from the rains by being placed to leeward of mountain-ranges, or by other causes. There are hence in India no vast plains clothed with gigantic timber-trees, such as cover immense areas of the American tropics; and even the valleys of the great Indian rivers, the Ganges, Nerbada, etc., are nowhere heavily timbered, but are generally absolutely destitute of forest, and extremely populous and highly cultivated*.

The tropical forests of India may be divided into those which inhabit perennially humid districts, and those which are confined to regions presenting contrasted seasons, of summer rain and winter drought.

The perennially humid forests are uniformly characterized by the prevalence of Ferns, and, at elevations below 5000–7000 feet, by the immense number of epiphytal *Orchideæ*, *Orontiaceæ*, and *Scitamineæ*: they contain a far greater amount of species than the drier forests, and are further characterized by *Zingiberaceæ*, *Xyrideæ*, Palms, *Pandaneæ*, *Dracæna*, *Piper*, *Chloranthus*, *Urticaceæ* (especially *Artocarpeæ* and *Fici*), *Araliaceæ*, *Apocyneæ*, shrubby *Rubiaceæ*, *Aurantiaceæ*, *Garciniaceæ*, *Anonaceæ*, Nutmegs, and *Dipterocarpeæ*.

The drier tropical forests of the regions with contrasted seasons, are much modified in luxuriance and extension by the winter cold in those extratropical latitudes over which they spread. In the chapter upon the meteorology of India, it is shown that though the summer heat scarcely decreases

* It is a much discussed question in India, whether the Gangetic plain was ever covered with forest: the best authorities consider that it never was so; but there are others who hold the contrary opinion, and aver that the destruction of the timber has produced a great change in the climate. The absence of vegetable remains in the alluvium appears unfavourable to the latter opinion.

with the increasing latitude till the 30th degree north, the cold of winter rapidly increases (see the map of Isothermals). Hence many tropical species, genera, and even families, which are sensitive to cold, are comparatively local when found beyond the tropic, as most Palms, *Cycas*, *Dipterocarpeæ* (except *Vatica*), *Aurantiaceæ*, *Connaraceæ*, *Meliaceæ*, *Myrtaceæ*, *Rubiaceæ*, *Ebenaceæ*, and many more. Others are indifferent to the cold of winter, provided they experience a great summer heat; these advance far beyond the tropic, and lend a more or less tropical aspect to the Flora even of the base of the north-western Himalaya, in 33° north. Such are many *Leguminosæ* (as *Bauhinia*, *Acacia*, *Erythrina*, *Butea*, *Dalbergia*, *Millettia*), *Bombax*, *Vatica*, *Nauclea*, *Combretaceæ*, *Verbenaceæ*, *Lagerstrœmia*, *Grislea*, *Jasmineæ*, and *Bignonia Indica*.

Passing from the forest vegetation to that of annual plants, we find that an immense proportion of these are uniformly distributed throughout India, and, vegetating only during the hot rainy season, are neither exposed to drought nor cold. Of these some of the most conspicuous are, besides *Gramineæ* and *Cyperaceæ*, a vast number of small *Leguminosæ* and *Scrophularineæ*, *Sida*, *Corchorus*, *Nama*, *Blumea* and other *Compositæ*, some *Labiatæ* (as *Leucas*, *Anisomeles*, etc.), *Amaranthaceæ*, *Acanthaceæ*, *Convolvulaceæ*, *Ludwigia*, *Jussieua*, etc.

Dr. Royle has well shown that this distribution of tropical annuals and of perennial-rooted plants with annual stems is not confined to the plains, but ascends the loftier mountain valleys as far as the well-marked rainy season extends, and that such plants only disappear where the accession of heat and humidity is not sufficient in amount or regular enough in period to stimulate their vegetative organs. Some of the most remarkable of these extratropical examples of tropical genera are species of *Begonia*, *Osbeckia*, *Argostemma*, *Plectranthus*, various *Cyrtandraceæ*, *Scitamineæ*, *Araceæ*, *Commelynaceæ*, and a few epiphytal *Orchideæ*.

A vegetation of a different nature from any of the above prevails in the extratropical regions of India during the cold months only; and, though contrasting in character with that of tropical annuals, is dependent upon analogous modifications of climate for its presence. This consists of annual plants of the north temperate zone that do not appear within the tropics (except at a considerable elevation), and which owe their southward extension into India to the winter's cold, just as the summer annuals owe their northward extension to the heat. These flower when the tropical plants are torpid: they are very numerous, comprising many European and cosmopolitan genera, and even species. Besides the winter crops of the Gangetic plain, consisting of Wheat, Barley, and more rarely Oats, with various kinds of pulse, there are, of wild plants, *Ranunculus sceleratus* and *muricatus*, *Capsella Bursa-pastoris*, *Silene conica*, *Alsine media*, *Arenaria serpyllifolia*, *Euphorbia Helioscopia*, *Medicago lupulina* and *denticulata*, *Lathyrus Aphaca*, *Gnaphalia*, *Xanthium*, *Veronica agrestis* and *Anagallis*, *Heliotropium Europæum*, various *Polygona*, *Juncus bufonius*, *Butomus umbellatus*, *Alisma Plantago*, and very many *Cyperaceæ*, Grasses, and such aquatics as *Myriophyllum*, *Potamogeton natans* and *crispus*, *Vallisneria*, *Zannichellia*, *Ranunculus aquatilis*, *Lemna*, and many others.

The transition from the tropical to the temperate Flora is more rapid in ascending above the level of the plains, than in advancing northward at the same level; the change of vegetation in a few thousand feet of ascent being much greater than in as many degrees of latitude as would compensate for the decrease of temperature experienced in that ascent. In the perennially humid provinces of India the climate of the base of the mountains is even more equable than that of the adjacent plains, from the atmosphere being more loaded with moisture. Hence in these regions a warm temperate Flora (neither strictly temperate nor markedly tropical) commences at elevations of 2–3000 feet, and prevails over the purely tropical, which appears in scattered trees,

shrubs, etc., amongst it. This vegetation presents many peculiar features, and its total absence from the plains is not to be accounted for by any simple law of climate. Amongst other Orders we may mention especially *Magnoliaceæ*, *Ternstrœmiaceæ*, subtropical *Rosaceæ* (as, *Prunus*, *Photinia*, etc.), *Kadsura*, *Sphærostema*, *Rhododendron*, *Vaccinium*, *Ilex*, *Styrax*, *Symplocos*, *Olea*, *Sapotaceæ*, *Lauraceæ*, *Podocarpus*, *Pinus longifolia*; with many mountain forms of truly tropical families, as Palms, *Pandanus*, *Musa*, *Clusiaceæ*, Vines, *Vernonia*, and hosts of others. These are instances of more or less strictly mountain plants prevailing uniformly over many degrees of latitude and longitude without ascending or descending much, but which are so rarely seen on the plains, as to entitle them collectively to a separate notice when treating of the phases of Indian vegetation.

Advancing westward, especially in the Himalaya, we experience a drier climate, which exaggerates the effect of elevation on the vegetation, and produces besides many curious anomalies, as a reduced mean temperature divided into two seasons, one of heat and one of cold, which are more contrasted at these elevations than on the plains. It is obviously impossible to enter here into the details of the apparent anomalies thus caused in the distribution of plants; each individual species demanding a study of its natural habits to explain its aptitude for an extended distribution in elevation, or geographical position, or its absolute restriction to a very narrow area, or to a few spots characterized by a combination of favourable circumstances. Examples may be seen in the *Ephedra* of the Panjab and north-western Himalaya, which ranges from the plains to 16,000 feet; in the genus *Marlea*, which ascends from 3000 to 8000 feet in Sikkim, and in the western Panjab, at scarcely 4000 feet, accompanies *Celtis* and a species of Ash; in a subtropical *Myrsine*, which extends even into Afghanistan; in *Juniperus excelsa*, found as low as 5000 feet in Afghanistan, and which ascends to 15,000 in Tibet.

Of the tropical and subtropical plants that accompany this high summer temperature and withstand the cold of considerable elevations, are many of those mentioned towards the commencement of this section as natives of dry tropical forests with contrasted seasons, at the level of the sea or on plains raised but little above it. *Populus Euphratica*, a *Cynanchum*, *Chloris barbata*, and *Cyperus aristatus*, all of which ascend to 11,000 feet in Ladak, are other remarkable instances, as is *Pegamum Harmala*, which attains 9000 feet.

In the Himalaya the truly temperate vegetation supersedes the subtropical above 4000–6000 feet; and the elevation at which this change takes place corresponds roughly with that at which the winter is marked by an annual fall of snow. This phenomenon varies extremely with the latitude, longitude, humidity, and many local circumstances. In Ceylon and the Madras Peninsula, whose mountains attain 9000 feet, and where considerable tracts are elevated above 6–8000 feet, snow has never been known to fall. On the Khasia mountains, which attain 7000 feet, and where a great extent of surface is above 5000, snow seems to be unknown. In Sikkim snow annually falls at about 6000 feet elevation, in Nipal at 5000 feet, in Kumaon and Garhwal at 4000, and in the extreme West Himalaya lower still.

It is hence only on the Himalaya and Mishmi mountains that a purely temperate flora prevails, to the exclusion of all tropical forms; though in Ceylon, the Nilghiri mountains, and Khasia, the temperate forms are very numerous, and so prevalent on the highest summits as to render it very desirable that these heights should be subjected to a very close botanical examination. Local circumstances, again, seem to bring the temperate forms lower upon the Khasia and Nilghiri mountains than upon the Himalaya, which are further north; and of these causes the fact that the exposed flat or undulated surfaces of the Khasia are swept by violent winds, is one of the most powerful. The contrast in this respect between the Khasia and the Sikkim-Himalaya is very remarkable, many

hundred species of temperate types common to both, being habitually found 1–3000 feet lower on the Khasia than in Sikkim. For the same reason many tropical types, and even species, ascend higher in Sikkim than they do in the Khasia; the warm forest-clad and sheltered Himalayan valleys at 5–7000 feet elevation, offering a very different climate to the broad grassy tops of the Khasia. Such apparent exceptions to the laws of distribution are frequent in India, rendering it very difficult for the beginner to comprehend even the general features of this branch of science, and for us to reduce them to such a system as shall be readily acquired.

It is unnecessary here to enumerate the prevalent forms of the temperate flora of India, including as they do every natural family, and almost every extensive or widely-spread genus of north Europe, Siberia, and colder temperate America, and this whether of shrubs, trees, or herbs. The exceptions become, however, the more important from their comparative paucity; of these we may mention the total absence of *Erica, Arbutus, Azalea, Fagus, Cochlearia, Cistaceæ, Tilia, Lupinus, Rhinanthus, Empetrum,* various *Umbelliferæ,* whilst we find but few species of *Hieracium, Trifolium, Centaurea, Veronica,* and *Dianthus.*

Of genera many of which have hitherto been usually considered as most characteristic of other parts of the world, but for whose maximum development we must look to the Himalaya, are *Rhododendron, Monotropa, Pedicularis, Corydalis, Nepeta, Carex, Spiræa, Primula, Cerasus, Lonicera, Viburnum,* and *Saussurea.*

Lastly, the Alpine or Arctic Flora demands a few words here, though it forms comparatively so small a feature in the vegetation of all India, that its full discussion must be reserved to our remarks on the Alpine region of the Himalaya. This, which hardly reaches its extreme upper limit at 18,500 feet above the sea, commences (as we restrict it) above the limit of trees throughout a great part of the Himalaya; it partakes in its characteristic genera of the temperate Flora,

and, though fully representing the Flora of the Polar regions, contains so many types that are foreign to them (as *Gentiana, Ephedra, Valerianeæ, Corydalis*), and some which are even rare in Siberia, that it must rather be considered as a continuation of the Alpine Flora of Europe than a representation of that of the Arctic zone. It displays one remarkable feature throughout its whole extent, a comparative paucity of Cryptogamic plants; and it is especially poor in those luxuriant mosses of tall growth and succulent habit, which form vivid and broad green tufts, loaded with rich brown capsules, and which abound both in the Alps and Polar regions. This is no doubt indirectly due to the elevation of the region, and directly to the sudden accessions of great heat and drought, which are the effects of a highly rarefied atmosphere, and which, though strongly enough marked to check the development of Mosses and Hepaticæ, are not of sufficient duration to affect phænogamic vegetation in the same degree.

b. *On the Distribution of Indian Plants as influenced by Geographical Position.*

Hitherto we have solely considered the spread of plants in India as influenced by climate, but geographical position is accompanied by such remarkable phenomena in vegetation, as to indicate other influences, which demand some notice here. The Floras of the frontier provinces of India, as we have repeatedly remarked, are identical with those of the countries that surround them, and are continuous with them, and that this should be so stands to reason; but we sometimes see a decided affinity between the Floras of areas separated by oceans, deserts, or mountain-chains, between which it is unwarrantable to assume that a migration of the species common to both, has taken place since the interposition of the barriers in question, and which further present many natural characters in common, which neither migration (if conceded to any amount) nor climate will account for. We have already

alluded to this subject in the third chapter of this Essay (p. 40), as one intimately connected with geological change, and as involving questions of the antiquity of species and of continents, which, as regards the Flora of India, we have no materials for discussing. It would be very easy to assume a few premises, and to suppose elevations and depressions of the islands, oceans, plains, and mountains of India, that would afford each area marked by a peculiar vegetation the means of having derived its species, or its botanical features, from another now isolated or distant region; and to extirpate species from areas where it would, for the theory's sake, be convenient to do so. It would also be easy to suppose climatic and other changes that would derange the whole existing order of vegetation, and to adapt the little we know of the Geology of India to support such movements; but we consider that all such speculations are unsafe and inexpedient in our present incomplete knowledge of any one branch of Indian science; they should be based primarily on geological data, and mainly on palæontological evidence that has been thoroughly sifted, should be well supported by zoological facts, and only extended to botany after the species of plants inhabiting the whole area shall have been approximately determined. It must not be supposed that, in declining to enter upon this subject, we are actuated by a spirit hostile to speculative reasoning; on the contrary, were we fully acquainted with the species and distribution of Indian plants, we would willingly throw out such suggestions as we think an analysis of them would legitimately warrant our advancing, and wait the result of zoological and palæontological evidence, with the hope, on the one hand, of establishing the truth of our deductions, and, on the other, in the belief, that if proved in the wrong, we should at any rate have erred within reasonable limits. But at this time in particular, when the labour of comparing and determining plants, and accumulating exact data, is shunned by the majority of botanists; when loose theories on geographical distribution, and on

the development of species, are replacing research; and when the data usually employed for deducing the laws of the distribution of plants consist of a compilation of raw materials from the works of travellers and local observers more or less skilled in botany, it becomes incumbent upon us, who hold that progress in this branch of botany depends on an exact knowledge of species, genera, families, and their affinities, to refrain from crude speculations as to the origin of the Indian Flora.

The following geographical alliances or affinities (if we may use the terms) of the Indian Flora, with more or less remote countries, we consider well established; they are capable of much illustration, even in the present state of our knowledge, but it is obviously impossible to dilate upon them here.

1. *The Australian type.*—The Flora of Australia is well known to contain far more endemic species and families than any other country does, and of these a few representatives extend into India. Besides *Pittosporum* and *Scævola,* which, though more characteristic of the Australian than of other Floras, are found all over India and Africa; there are two species of *Stylidium,* which are the only extra-Australian ones known: one of these extends up the Malay peninsula to Silhet, and is also said to be found at Midnapore on the west side of the Gangetic delta; and the other is confined to the Malay peninsula. Several species of Australian genera of *Myrtaceæ* (*Leptospermum, Bæckia,* and *Metrosideros*) inhabit the same peninsula, besides the very remarkable genus *Tristania,* which advances to Moulmein in 17° N. lat. *Casuarina,* which is cultivated throughout India, is wild on the east coast of the Bay of Bengal as far north as Ramri; and of *Helicia* (a Proteaceous genus) several species abound in the Malay peninsula, and one extends to Silhet, and along the base of the Himalaya to Central Nipal. *Lagenophora,* a small Australian genus of *Compositæ* (also found in New Zealand and Fuegia), has a representative in the Khasia and Ceylon. We thus see that Australian types are almost confined to a

meridian east of the Ganges; and the only important exceptions known to us are another species of *Helicia* in Ceylon, *Lagenophora* in the same island, and the curious genera *Acrotrema* and *Schumacheria* of *Dilleniaceæ*, which are more nearly allied to Australian forms of that Order than to any others, and of which *Schumacheria* is confined to Ceylon, *Acrotrema* being also found in the Malayan peninsula and in Malabar.

2. *The Malayan Archipelago type.*—This forms the bulk of the Flora of the perennially humid regions of India; as of the whole Malayan peninsula, the upper Assam valley, the Khasia mountains, the forests of the base of the Himalaya from the Bramaputra to Nipal, of the Malabar coast, and of Ceylon. It is of course impossible to specify the genera or even families of so predominant an element; to do so would be to enumerate a very large proportion of the Indian genera, and to except only the north temperate and the comparatively few African types. The extent, however, to which this element predominates is not yet appreciated, nor do we ourselves know its total amount; for constantly, during our examination of the temperate as well as tropical plants of the Nilghiri, Khasia, Ceylon, and the Himalaya, we find them identical in species with Javanese mountain plants. That botanists have neglected comparing these Indian plants with Javanese Floras is not surprising, when it is considered how remote Java is from any part of continental India, and that geographical isolation is by many considered equivalent to specific difference. We are, however, convinced, after a very careful examination, that there are several plants, as *Gaultheria nummularia*, which extend into the North-west Himalaya, and are also found in the Javanese mountains, which are nearly 3000 miles distant: some of these have already been found in intermediate localities, as the *Gaultheria*, which occurs along the whole Himalayan range, and in the Khasia, and which will probably be found in the mountains of the Malay peninsula and of Sumatra; and there are many other Java plants which are more uniformly spread over the

hilly districts of India and Ceylon. Amongst the more conspicuous trees common to Java and India are *Sedgwickia cerasifolia*, Griff., a native of Assam, which is undoubtedly the *Liquidambar Altingia* of Blume; *Marlea*, which spreads into China on the one hand, and throughout the Himalaya to the mountains south of Kashmir on the other. The curious *Cardiopteris lobata* of Java is also a native of Assam, and several oaks and chesnuts, *Antidesmæ*, a willow, and *Myrica*, have already proved to be common to the Khasia and Java.

3. *The China and Japan type.*—In the Indian flora we meet with many temperate genera and species, which are also common to North America west of the Rocky Mountains, and which are foreign to Europe, to America east of that range, and to Western Siberia; besides many tropical species that are also Malayan and West Polynesian. The Chinese type is abundant in the temperate regions of the Himalaya, extending westward to Garhwal and Kumaon, but is most fully developed in Sikkim, Bhotan, and the Khasia. Amongst the most striking examples of its temperate forms in the Himalaya, are species of *Aucuba, Helwingia, Stachyurus, Enkianthus, Abelia, Skimmia, Bucklandia, Adamia, Benthamia, Corylopsis,* genera that have been considered as almost exclusively Japanese and Chinese, and of most of which there are but solitary species known in that country.

Other temperate plants common to India and China are *Microptelea parvifolia* (a species of elm) ; *Hamamelis Chinensis,* found by us in the Khasia; *Nymphæa pygmæa,* and *Vaccinium bracteatum,* both of which occur in the Khasia; and *Quercus serrata,* which is a native of Nepal, Sikkim, and the Khasia. Besides these cases of absolute identity of species, many Chinese genera may be noticed. *Illicium* inhabits the Khasia, *Thea* Assam; and *Magnolia,* Sikkim and Khasia. *Schizandreæ* are peculiarly characteristic of the Chinese Flora, but also extend into Java; *Lardizabaleæ,* which attain their maximum of development in the Himalaya, are Japanese and Chinese, a few only having hitherto been de-

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tected in temperate South America. Other instances are *Camellia, Deutzia, Hydrangea, Viburnum,* several *Corneæ,* and *Houttuynia.*

The recent able investigation of the Hongkong Flora by Major Champion and Mr. Bentham has materially increased our knowledge of the intimate relationship between the Floras of China and the eastern parts of India; amongst many instances, we may select the remarkable genus of Ferns, *Bowringia*,* found in Hongkong and in the Khasia mountains; *Wikstrœmia,* a genus of *Daphneæ; Bucklandia, Enkianthus, Henslovia, Scepa, Antidesma, Benthamia, Goughia, Myrica,* and very many others; in fact, there is scarcely a genus in the whole Hongkong Flora that is not also Indian. *Euryale ferox,* which is wild in the Gangetic delta, and is found as far westward as Kashmir, is abundant in China; and *Nepenthes phyllamphora,* a native of the Khasia mountains, is also found at Macao, and eastward to the Louisiade Archipelago.

4. *The Siberian type.*—This is characteristic of the colder temperate parts of Asia, and is very fully represented in the upper temperate and alpine regions of the Himalaya, descending in the north-western and drier parts of the chain to very low levels. It approaches, in many respects, to the South European vegetation, but is characterized by the predominance of *Fumariaceæ, Potentillæ, Leguminosæ,* especially *Hedysarum* and *Astragaleæ,* of *Umbelliferæ, Lonicera, Artemisia, Pedicularis,* and *Boragineæ;* and by the rarity or total absence of certain groups or genera which are especially abundant in Europe, such as *Cistaceæ, Rosa, Rubus, Trifolium, Erica,* Ferns, and other cryptogams. As the Alps of Central Asia rise gradually from the elevated tracts of Southern Siberia, and possess a very similar climate, the increasing elevation compensating for the diminution of latitude, a very Siberian

* *Bowringia* of Hooker, 'Kew Journal of Botany,' vol. v. p. 237. A name superseded by the *Bowringia* of Bentham, in Hooker's 'Kew Journal of Botany,' vol. iv. p. 75.

Flora predominates throughout the drier regions of the Himalaya*. Siberian forms are, however, by no means confined to the drier parts of the chain, but may be observed even in the most humid regions of the Himalaya, and occasionally even on the mountains of tropical India. Thus *Artemisia* and *Astragalus*, which are perhaps the most characteristic genera of the Siberian type of vegetation, are not only abundant throughout Tibet and the interior Himalaya, but are represented by a few species in the plains of the Panjab, on the outer slopes of the western Himalaya, and even on the Khasia mountains. *Spiræa Kamtchatica, chamædrifolia,* and *sorbifolia,* and *Paris polyphylla,* are also Siberian forms which extend into the rainy Himalaya; and *Corydalis Sibirica* and *Nymphæa pumila* are remarkable instances of specific identity between Khasia and Siberian plants†.

5. *The European type.*—The extent to which European plants abound in India has never hitherto been even approximately appreciated. Dr. Royle was the first to indicate this affinity between the vegetation of the eastern and western continents of the old world; and throughout his writings we find constant evidence of his never having lost sight of this being a marked feature. Had the collections, upon which he founded his conclusions, been critically compared and worked out, the keystone to the whole system of distribution in Western Asia could not have escaped him, which does not rest so much upon a number of representative species, as

* As a few instances, besides the many *Ranunculaceæ* and *Fumariaceæ* enumerated in the pages of the present volume, we may mention *Tauscheria desertorum*, *Biebersteinia odora*, *Potentilla Salessovii*, *multifida*, and *bifurca*, *Chamærhodos sabulosa*, *Pyrus baccata*, *Astragalus contortuplicatus*, *densiflorus*, and *subulatus*, *Phaca frigida*, *Oxytropis diffusa*, *Cicer Soongaricum*, *Sedum quadrifidum*, *Artemisia Dracunculus*, *scoparia*, *Tournefortiana*, *fasciculata*, and *salsoloides*, *Saussurea latifolia* and *pygmæa*, *Mulgedium Tataricum*, *Osmothamnus fragrans* (*Rhododendron anthopogon*, Don), *Salix augustifolia*, *Populus balsamifera*, *Carex microglochin*, *stenophylla*, *physodes*, *supina*, and *tristis*.

† It is curious to remark that there are in Siberia a certain number of forms indicative of tropical Indian types, as, for instance, *Menispermum* and *Anandria*.

upon the fact that not only are a large proportion of annual and herbaceous species of each common to Western India and Europe, but of shrubs and trees also.

Although the progress we have hitherto been able to make in critically examining our own Indian collections is very limited, we have already established the identity of so many Himalayan plants with European ones, as to oblige us to look to a common origin for the species found in both these regions, and to seek for causes no longer in operation to account for their distribution over so extended an area. The mountain mass of Asia, as is well known, sinks to the westward of Afghanistan, rising again only in isolated peaks; and hence the Himalaya is rather ideally than really connected with the mountains south of the Caspian, and so with the Caucasian Alps on one hand, and those of Asia Minor on the other; nevertheless we find a multitude of mountain plants, and indeed many of the most conspicuous ones of Europe, ranging from the coasts of the Levant and the Black Sea to the Himalaya. Of these, again, some are confined within these limits, as *Corylus Colurna* (*C. lacera*, Wall.); others spread no further east than the North-western Himalaya, but continue westward to the south of Spain, as *Quercus Ilex, Ulmus campestris, Celtis australis* and *orientalis*; and others, again, advance eastward, spreading over the whole Himalaya, as the Walnut, Ivy, Juniper, and Yew, some of which extend into the Khasia; and two, Juniper and Yew, spread yet further across China, Mexico, and throughout North America. These European forms are almost confined to the temperate regions of India, and with them we also find abundantly the herbs and shrubs of Northern Europe, inhabiting a loftier level in the Himalaya, where they blend with the Siberian types. We cannot conceive anything more valuable or suggestive to the student of geographical distribution than an accurate list of these European plants, which may be grouped under three heads:—1. Such as are common to most parts of Europe, Northern Asia, and North America, and the Himalaya, such as the Yew,

Juniper, *Aquilegia vulgaris, Caltha palustris*, etc. 2. Those which are confined to Europe and India. These, again, belong partly to the Mediterranean Flora, as, for instance, *Celtis, Quercus Ilex, Olea Europæa, Myrtus communis*, etc.; and partly to that of Europe north of the Alps, including the greater number of herbs and small shrubs. Meanwhile we shall here confine ourselves to subjoining a list of 222 British plants which extend into India. Many of these require a more critical comparison; but we are convinced that the errors which may be detected in our enumeration are too few to invalidate the important general law. The list, indeed, is very far from complete, as we have omitted all plants regarding which we are not tolerably certain.

Thalictrum *alpinum.*
„ *minus.*
Ranunculus *aquatilis.*
„ *Lingua.*
„ *sceleratus.*
„ *arvensis.*
Caltha *palustris.*
Aquilegia *vulgaris.*
Actæa *spicata.*
Berberis *vulgaris.*
Nymphæa *alba.*
Papaver *dubium.*
„ *hybridum.*
Fumaria *Vaillantii.*
Nasturtium *amphibium.*
„ *officinale.*
Barbarea *vulgaris.*
Turritis *glabra.*
Cardamine *hirsuta.*
Sisymbrium *Sophia.*
„ *thalianum.*
Alliaria *officinalis.*
Draba *incana.*
„ *verna.*
Thlaspi *arvense.*
Hutchinsia *petræa.*
Lepidium *latifolium.*
„ *ruderale.*
Capsella *Bursa-Pastoris.*
Silene *inflata.*
„ *conica.*
Sagina *procumbens.*
Arenaria *serpyllifolia.*
Holosteum *umbellatum.*
Stellaria *media.*
Cerastium *vulgatum.*
Hypericum *perforatum.*
Geranium *lucidum.*
„ *Robertianum.*
Erodium *cicutarium.*
Oxalis *Acetosella.*
„ *corniculata.*
Ononis *arvensis.*
Medicago *lupulina.*
„ *denticulata.*
Melilotus *officinalis.*
„ *vulgaris.*
Trifolium *pratense.*

Trifolium *repens.*
„ *fragiferum.*
Lotus *corniculatus.*
Ervum *tetraspermum.*
„ *hirsutum.*
Vicia *sativa.*
Lathyrus *Aphaca.*
Prunus *Padus.*
„ *Avium.*
Agrimonia *Eupatoria.*
Alchemilla *vulgaris.*
Sibbaldia *procumbens.*
Potentilla *rupestris.*
„ *anserina.*
„ *verna.*
„ *reptans.*
Fragaria *vesca.*
Rubus *fruticosus.*
„ *saxatilis.*
Geum *urbanum.*
Rosa *spinosissima.*
„ *rubiginosa.*
Cratægus *Oxyacantha.*
Cotoneaster *vulgaris.*
Pyrus *Aria.*
Lythrum *Salicaria.*
Epilobium *palustre.*
„ *parviflorum.*
„ *tetragonum.*
„ *montanum.*
„ *roseum.*
„ *alpinum.*
Circæa *lutetiana.*
Myriophyllum *verticillatum.*
Hippuris *vulgaris.*
Sedum *Telephium.*
„ *Rhodiola.*
Ribes *Grossularia.*
„ *nigrum.*
Saxifraga *granulata.*
„ *cernua.*
Sium *angustifolium.*
Daucus *Carota.*
Torilis *Anthriscus.*
Scandix *Pecten.*
Hedera *Helix.*
Galium *tricorne.*
„ *Aparine.*
„ *boreale.*
Valerianella *dentata.*
Tussilago *Farfara.*
Bidens *tripartita.*
„ *cernua.*
Achillea *Millefolium.*
Artemisia *vulgaris.*
„ *maritima.*
„ *Absinthium.*
Senecio *Jacobæa.*
Lappa *major.*
Centaurea *Calcitrapa.*
Silybum *Marianum.*
Lapsana *communis.*
Cichorium *Intybus.*
Picris *hieracioides.*
Sonchus *oleraceus.*
„ *arvensis.*
Campanula *latifolia.*
Pyrola *rotundifolia.*
Erythræa *Centaurium.*
Villarsia *nymphæoides.*
Polemonium *cæruleum.*
Convolvulus *arvensis.*
Asperugo *procumbens.*
Lycopsis *arvensis.*
Lithospermum *arvense.*
Myosotis *arvensis.*
Solanum *nigrum.*
„ *Dulcamara.*

Hyoscyamus *niger*.
Orobanche *cærulea*.
Lathræa *squamaria*.
Verbascum *Thapsus*.
Antirhinum *Orontium*.
Linaria *Elatine*.
Euphrasia *officinalis*.
Veronica *Anagallis*.
„ *Beccabunga*.
„ *officinalis*.
„ *verna*.
„ *triphyllos*.
„ *agrestis*.
Origanum *vulgare*.
Thymus *Serpyllum*.
Clinopodium *vulgare*.
Scutellaria *galericulata*.
Prunella *vulgaris*.
Nepeta *Cataria*.
Lamium *amplexicaule*.
Stachys *arvensis*.
Marrubium *vulgare*.
Verbena *officinalis*.
Utricularia *minor*.
Glaux *maritima*.
Samolus *Valerandi*.
Salsola *Kali*.
Atriplex *patula*.
Chenopodium *album*.
„ *viride*.
Rumex *palustris*.
„ *obtusifolius*.
„ *Acetosa*.
Oxyria *reniformis*.
Polygonum *Bistorta*.
„ *viviparum*.
„ *Hydropiper*.
„ *aviculare*.
Hippophae *rhamnoides*.
Buxus *sempervirens*.
Euphorbia *helioscopia*.
„ *Peplus*.
„ *exigua*.
Callitriche *aquatica*.
Parietaria *officinalis*.
Ulmus *campestris*.
Salix *purpurea*.
„ *alba*.
Orchis *latifolia*.
Convallaria *verticillata*.
Lloydia *serotina*.
Gagea *lutea*.
Juncus *glaucus*.
„ *lamprocarpus*.
„ *bufonius*.
Alisma *Plantago*.
Sagittaria *sagittifolia*.
Butomus *umbellatus*.
Triglochin *maritimum*.
„ *palustre*.
Sparganium *ramosum*.
Acorus *Calamus*.
Lemna *minor*.
Potamogeton *natans*.
„ *perfoliatus*.
„ *crispus*.
„ *gramineus*.
Zannichellia *palustris*.
Eleocharis *palustris*.
„ *acicularis*.
Scirpus *maritimus*.
Blysmus *rufus*.
Carex *incurva*.
„ *divisa*.
„ *remota*
„ *atrata*.
„ *rigida*.
„ *ustulata*.

Carex *flava.*	Poa *alpina.*
„ *Pseudo-cyperus.*	„ *nemoralis.*
„ *ampullacea.*	„ *pratensis.*
„ *paludosa.*	Dactylis *glomerata.*
Alopecurus *pratensis.*	Festuca *ovina.*
Polypogon *Monspeliensis.*	Brachypodium *sylvaticum.*
Agrostis *vulgaris.*	Bromus *tectorum.*
Kœhleria *cristata.*	Lolium *temulentum.*
Poa *annua.*	Hordeum *pratense.*

One very remarkable result has already struck us with regard to the Himalayan distribution of European plants, namely, their rapid disappearance to the east of Kumaon. Few species, comparatively, extend into Nipal, and still fewer occur in Sikkim. Thus *Myrtus communis,*—to mention only a few instances,—is not found further east than Afghanistan; *Nymphæa alba, Marrubium vulgare, Nepeta Cataria, Potentilla reptans,* and *Trifolium fragiferum,* have not been observed beyond Kashmir; *Cratægus Oxyacantha* stops in Kishtwar; *Rubus fruticosus* in the outer hills near Jamu; and *Aquilegia vulgaris* in Kumaon. There is thus a blending of European forms with the proper Himalayan Flora in the western parts of the chain, just as, to the eastward, we find Chinese and Malayan forms intermixed with it. How far this curious fact is due to climatic or physical causes, our present data do not enable us to decide. It cannot however, we think, be disconnected from the gradually diminishing rain-fall of the more western Himalaya. We ought also not to forget that in the longitude of Kumaon there exists a great watershed, which stretches north-east as far as the sea of Japan; for, however little this point of physical structure may now affect the vegetation of the outer regions of the Himalaya, its influence during the elevation of the land must have been very considerable.

6. *The Egyptian type.*—Egypt, Southern Arabia, and the warmer parts of Persia, possess a remarkable similarity of climate to Beluchistan, Sind, and the Panjab, and at the same

time a nearly complete identity of vegetation. Many North African or Arabian forms, such as *Peganum Harmala, Fagonia Cretica, Balanites Ægyptiaca, Acacia Arabica, Alhagi, Grangea, Calotropis, Salvadora Persica,* extend throughout all the drier parts of India. Others have a less extensive range, being only found in Northern and Western India: of these, *Malcolmia Africana, Farsetia,* several species of *Cleome, Balsamodendron, Astragalus hamatus* and others, *Cucumis Colocynthis, Berthelotia, Anticharis Arabica,* spinous *Acanthaceæ, Cometes, Forskalea, Populus Euphratica, Ephedra, Salix Ægyptiaca, Crypsis,* etc. etc., may be mentioned as instances. In India, as in Africa, this peculiar vegetation passes by insensible gradations into the European Flora on the one hand, and into the tropical on the other.

7. *The Tropical African type.*—Though tropical Asia and Africa are separated by a vast expanse of ocean, there is a striking similarity in their vegetation. This is shown not only by the identity of the annual vegetation which springs up during the rainy season*, but by a great similarity in the families and genera of the trees and shrubs: *Capparis, Grewia, Sterculiaceæ, Tiliaceæ,* columnar *Euphorbiæ,* and many other *Euphorbiaceæ, Antidesma, Lepidostachys, Olacineæ, Acacia,* and *Rubiaceæ,* may be mentioned as examples.

Too little is known of the African Flora to enable any definite conclusions to be drawn as to the numerical value of this type in India, but it is evidently an important one†.

A curious affinity may also be traced between the mountain vegetation of western tropical Africa and that of the Peninsular chain, where the absence or comparative rarity of many of the principal features of the Malayan Flora has already

* *Polanisia, Gynandropsis, Urena, Sida, Melochia, Riedleya, Corchorus, Triumfetta, Æschynomene, Smithia, Indigofera, Dolichos, Ammannia, Cucurbitaceæ, Blumea, Vernonia cinerea, Exacum, Scrophulariaceæ, Leucas, Ocymum, Hedychium, Amomum, Gloriosa, Commelynaceæ,* Grasses, and *Cyperaceæ.*

† The *Melianthus Himalayanus,* described by Planchon, is a garden plant, introduced from the Cape of Good Hope into the Himalaya, and is not distinct from the common Cape species.

been remarked. With our present knowledge, this affinity is chiefly indicated by the occurrence of Indian natural orders or genera, such as *Stephania, Grewia, Hippocratea, Impatiens, Brucea, Zizyphus, Anogeissus, Blumea, Jasminum, Torenia;* and by the prevalence of those tribes of the larger or cosmopolitan families which are especially Indian. This is the case with *Malvaceæ, Euphorbiaceæ, Terebinthaceæ, Leguminosæ, Rubiaceæ, Asclepiadeæ, Acanthaceæ, Amaranthaceæ,* Figs, and *Orchideæ.* Few cases of specific identity are known to us, but we confidently believe that many will be found to exist. The occurrence of *Delphinium dasycaulon* of Abyssinia in the mountains of the Dekhan is one instance; and we have little doubt, notwithstanding that M. Ach. Richard attempts to distinguish it, that *Pterolobium lacerans* is identical with the Indian species. The Indian plants, *Sponia velutina* and *Antidesma paniculata,* are also African; and the *Celtis eriocarpa* of Decaisne appears identical with *C. vesiculosa,* Hochst., from Abyssinia. Lastly, the absence of Oaks and Pines in both countries is a very strong point of resemblance.

There are further examples of American genera, and even species, being found in India, but so few and scattered, comparatively, as to render it unadvisable to complicate our arrangement by the introduction of an American type. As conspicuous examples, it will be sufficient to indicate *Adenocaulon* and *Oxybaphus,* of which genera the Indian species were first described by Edgeworth; *Podophyllum,* the section *Stylopodium* of *Meconopsis,* and *Liquidambar.* *Gnetum* also is a South American genus, which has not hitherto been found in Africa; and *Lardizabala* is interesting as a Chilian genus of a small order, the rest of which is entirely East Asiatic. *Monotropa uniflora* and *Brasenia* are common to North America and India; and the curious little *Mitreola paniculata,* Wall., is remarkable as being a native of India and Brazil, and, so far as is known, of no intermediate country*.

* The West African and East tropical American coasts afford curious examples of a similar relationship in the identity of species of *Schmidelia,* and in the

We cannot dismiss this branch of the subject without alluding to a few anomalies in the distribution of Indian plants. Of these, the most remarkable are the prevalence of Oaks and Chesnuts throughout the Himalaya, Khasia, and Malayan Peninsula, descending to the level of the sea in East Bengal, Malaya, Sumatra, Java, and Borneo, contrasted with their total absence throughout the Peninsula of Hindostan and Ceylon. Secondly, the prevalence of *Coniferæ* (along with these Oaks), not only inhabiting high levels, but descending considerably below 4000 feet: of these, *Pinus, Podocarpus, Taxus,* and *Dacrydium,* are all found in the Malay Peninsula and Khasia, but not one in the Hindostan Peninsula or Ceylon, though these present far more extensive and loftier mountain-ranges. Thirdly, we would call attention to the absence of *Cycadeæ* in Ceylon, and to the comparative rarity of Palms and epiphytic *Vacciniaceæ* in that island and in the Peninsula of Hindostan.

D. *Enumeration and description of the Provinces of India, as they will be referred to in the 'Flora Indica*.'*

The primary divisions of Continental India are four:— 1. *Hindostan,* in the widest sense of that term, including the

representation of several curious peculiar genera. The Atlantic Islands and North America show an equally striking instance, in a representative species of the otherwise American genus *Clethra,* inhabiting Madeira; North America and Western Europe present others in *Eriocaulon septangulare, Trichomanes brevisetum,* etc. China and Japan present similar analogies with the west coast of North America. The most curious instance of all is, however, the occurrence in New Zealand of Chilian species of *Edwardsia* and *Haloragis,* and of representatives of *Fuchsia, Calceolaria,* and other genera, which are found nowhere else throughout the Old World.

* The sources from which the published facts contained in the following pages are derived are too numerous and too well known to make it desirable to quote them. For many details regarding those districts which we have not ourselves seen, we have to thank Dr. Wallich, Dr. Wight, Dr. Gibson, Dr. Stocks, and Captain R. Strachey. The last-named gentleman has also very kindly allowed us to make use of tables of mean temperature and rain-fall, collected with great labour for his work on the Physical Geography of the Himalaya, now in the press.

whole Western (Madras) Peninsula, and the Gangetic plain to the base of the Himalaya. 2. The *Himalaya*, a mountain chain which rises abruptly from the Gangetic plain, and is connected with a still loftier mountain mass (of Tibet) to the north, and beyond India. 3. *Eastern India* (India ultra Gangem), including the kingdom of Ava and the Eastern or Malayan Peninsula. 4. *Afghanistan.*

The direction of the great mountain barrier of India on the north is not parallel to the Equator, the western extremity being the most northern. Its height is immense, being nowhere below 15,000 feet, usually exceeding 17,000–18,000, and rising in isolated peaks, or groups of peaks, to from 20,000–28,000. The Afghan mountains form a meridional chain from the western extremity of the above, descending parallel to the Indus, with a gradually decreasing elevation, from above 15,000 feet, to the level of the sea, at the Arabian Gulf. The Ava and Malayan mountains form a chain parallel to these, which is given off from the snow-clad mountains of East Tibet, and, though rapidly diminishing in elevation, is continued uninterruptedly almost to the Equator.

In Europe, *Hindostan* is generally understood to comprise the whole continent of India, from the base of the Himalaya to Cape Comorin; but in India the term is frequently restricted to the provinces north of the Nerbada, whilst all those to the southward of that river are called the Dekhan, or southern provinces. In this work, however, we shall give to the term Hindostan its most extended sense, and restrict that of Dekhan to the elevated country north of Mysore.

A complicated system of mountain-chains gives to Hindostan its peculiar configuration; these, which may be traced by following on a map the courses of the rivers of which they form the watersheds, are three in number, and bear no obvious relation to one another. They are,—1. The Peninsular chain (also called Ghats and Western Ghats) extending from Cape Comorin to the Tapti river. 2. The Vindhia chain, which crosses the centre of Hindostan from the Gulf

of Cambay to the Ganges. 3. The Arawali mountains, extending from Hansi and Delhi to Gujerat.

1. The *Peninsular chain* is the most important of these; it forms a continuous watershed, throughout its length of upwards of nine hundred miles, scarcely deviating from a straight line, which is parallel and close to the west coast of the Peninsula, and perpendicular to the direction of the monsoons. This chain divides the Peninsula unequally into two portions, marked by different climates,—a narrow western one, including the provinces of Malabar and the Concan; and a broad eastern one, traversed consequently by all the great rivers, and including the Carnatic, Mysore, and the Dekhan. Khandesh lies to the north of the chain, and includes that portion which sinks into the Tapti valley, together with the southern (opposite) slope of the Satpura branch of the Vindhia to the north of that river.

2. The *Vindhia chain*, from the little that is known of its structure, appears to consist of two parallel ranges, connected towards their centres, where the table-land of Umarkantak is said to attain an elevation of 4500 feet; elsewhere they are separated by the great rivers Son and Nerbada, which rise together and flow in opposite directions. The more southern of these ranges is probably always the higher of the two, but it appears seldom to exceed 3000 feet. The Vindhia mountains separate the Ganges and its tributaries from those rivers (the Mahanuddy, etc.) which flow south-east to the Bay of Bengal, as also from the Tapti and Nerbada, which flow west to the Arabian Sea. To the south of the range are the provinces of Khandesh, Berar, and Orissa; and to the east and north is the Gangetic valley, extending to the base of the Himalaya, and forming one great botanical province.

3. The *Arawali chain* is the least elevated of the three: it divides the tributaries of the Indus from those of the Ganges, and may hence be regarded as a continuation of the Cis-Satlej chain of the Himalaya, which terminates, to all appearance, in the plains near Nahan in Sirmur. In like manner, the Penin-

sula of Katiwar may be considered as the southern termination of the Arawali, though separated from it by an alluvial plain, being the continuation of the watershed, and dividing the streams flowing to the Gulf of Kach (or the delta of the Indus) from those that flow into the Gulf of Cambay.

We shall now proceed to give a rapid sketch of the physical features of the provinces of Hindostan, commencing with the southernmost. These are—

1. Ceylon.	7. Khandesh.	13. Gujerat.
2. Malabar.	8. Berar.	14. Sind.
3. Concan.	9. Orissa.	15. Rajwara.
4. Carnatic.	10. Bahar.	16. Panjab.
5. Mysore.	11. Bandelkhand.	17. Upper Gangetic plain.
6. Dekhan.	12. Malwah.	18. Bengal.

1. Ceylon.

This island extends from 6° almost to 10° N. lat., and is about 200 miles long, and 150 in greatest width. It is encircled by a belt of level land, which forms extensive plains at the northern extremity; and is traversed by a meridional chain of mountains. These mountains form a narrow range towards the north, seldom exceeding 1000 feet in elevation, and sink into the plain eighty miles from that extremity; to the southward they spread out, attain nearly 9000 feet of elevation, and extend eastward from Adam's Peak to Maha Ellia (or Horton plains) and Newera Ellia. The main ridge retains, perhaps, 6000–7000 feet of mean elevation for thirty miles, and expands into elevated plains of considerable extent, from which the loftier peaks rise. To the south and east, this transverse ridge dips abruptly into a low but hilly forest-clad country, but to the north it gives off a number of meridional ranges of considerable height; these separate tributaries of the Mahawali river which flow in elevated mountain valleys.

The great extent and elevation of the high land in Southern Ceylon powerfully influences the climate of the whole island. During the south-west (or summer) monsoon the north and

east parts receive but little rain, which is all deposited on the intervening heights; the belt of low land in the south is, on the contrary, abundantly moist at the same season. During the north-east (or winter) monsoon, the rain-fall on the mountains, though considerable, is less than during summer, this wind being cooler and having less capacity for moisture; but showers occur at this season throughout the northern parts of the island. During winter, heavy rain falls along the southern coast.

The difference in climate presented by the various parts of Ceylon is hence very great. In the mountainous districts, where every wind is a moisture-laden sea-wind, it is temperate, equable, and humid throughout the year. The southern parts experience the moist tropical heats of an almost equatorial climate, and this at a season when the north coasts are scorched with dry heat. The mean temperature of Trincomali hence rises to 81½°; and its climate is so dry, that when Mr. Gardner visited it, he found there had been no rain for nine months,—both anomalous conditions, when the proximity of the ocean is considered. Kandy, again, in the centre of the island, which is only 1800 feet above the sea, and is situated in a mountain valley, has a mean temperature of about 73°, and that of Newera Ellia, elevated 7000 feet, is probably about 60°.

The coast of Ceylon is generally fringed with a belt of Cocoa-nuts, which vegetate luxuriantly in the sandy soil of the sea-shore. In the estuaries, mangroves (*Rhizophora*) inhabit the muddy swamps, accompanied with *Heritiera*, *Sonneratia*, *Lumnitzera*, *Avicennia*, and *Scævola*, but none of the *Phœnix paludosa* and *Nipa fruticans*, so characteristic of the Sunderbunds.

In the drier flat parts of the island, extensive sandy plains covered with short grass alternate with undulating downs, either bare or clothed with dense thickets of thorny shrubs. The plants of these parts are generally those of the Carnatic, the climate being the same.

A dense forest clothes all the humid southern and western parts of the island, composed of plants eminently characteristic of Malabar. The vegetation of the upper and lofty districts is more mixed with temperate forms, and is extremely luxuriant, containing many, and indeed composed almost exclusively, of the species of the great Peninsular chain. Besides the mountain-slopes being covered with dense forests, there are open and undulating lofty table-lands which appear, like those of the Nilghiri and Khasia, to be clothed with large clumps of shrubs, swards of grass, and a rich herbaceous vegetation, the large trees being confined to the ravines. In these places, *Ternstrœmiaceæ, Rhododendron arboreum, Vaccinia, Gaultheria, Symploci, Michelia, Goughia,* and *Gomphandra,* seem as frequent as they are on analogous elevations of the continental ranges.

Though the Flora of Ceylon (which probably does not contain 3000 phænogamic plants) is on the whole identical with that of the peninsula, it presents a considerable number of endemic species, and a few genera, especially tropical ones, which are not found in the peninsula. *Dilleniaceæ, Anonaceæ, Garciniaceæ, Balsamineæ,* are all abundant in Ceylon. Its most remarkable deficiencies are *Scitamineæ,* Oaks, Willow, *Nipa, Gnetum, Pinus, Podocarpus, Cycas.* It presents also but few Palms: amongst these the most conspicuous are Cocoanut (cultivated only), *Corypha umbraculifera, Borassus flabelliformis, Phœnix farinifera, Caryota urens,* an *Arenga, Areca,* and several *Calami.* This is a remarkably small number, when the Flora is contrasted with the Malayan*.

The Cingalese Flora has been investigated by a succession of industrious botanists, but no attempt at an enumeration of

* The adaptation of the soil and climate of the lowest and hottest parts of Ceylon to the ripening of grapes, is a most remarkable fact connected with the cultivation of the vine. Mr. Edgar Layard (whose zoological researches in Ceylon are so well known and appreciated) informs us that at Jaffna, at the northern extreme, the grape is grown successfully. The cold weather or north-east monsoon sets in there early in November, and the "sweet water" fruits in May and in October, and the "black cluster" in September; after fruiting,

its plants has been made since the publication of Moon's inefficient catalogue. Owing to the extent and impenetrability of the forests, some novelties must still remain; and many of the species, being large timber-trees and diœcious plants, varying abundantly, require skilful analysis and observation in the country. We have already mentioned Burmann's and Linnæus's labours. Moon was the first English collector, and curator of the Government Botanical Gardens at Peradenia, near Kandy. His collections (according to Gardner, Lond. Journ. Bot. iv. 397) were extensive and good, and formed the foundation of the Peradenia Herbarium, which is now rapidly acquiring a European fame, through the successive exertions of Gardner and Thwaites, Moon's successors in charge of the garden; and of Major Champion, who resided several years in the island. Moon's plants were never distributed; but other and most extensive collections have been, of which the following are the most important:—1. Macrae's, a collector in the service of the Horticultural Society of London.—2. Colonel and Mrs. Walker's: these were both extensive and excellent, and were illustrated by many drawings and manuscripts.—3. Major Champion's, alluded to at p. 69.—4. Mr. Gardner's; abundant and good: these were in part distributed, in part sold after his decease, while a part remain in the Peradenia Herbarium. Gardner has published several papers on Ceylon plants in the 'Journal of Botany,' and in the 'Calcutta Journal of Natural History;' sometimes in conjunction with Major Champion.

Mr. Thwaites, the present able superintendent of the Peradenia Botanic Gardens, has for several years continued energetically the investigation of the flora of the island which was commenced by Mr. Gardner; bringing his great botanical acquirements, skill in analysis, and powers of observing and

an artificial winter is produced by exposing the roots, and bullocks' blood is used as manure. According to the same authority, the grape also bears well at Tangalle, at the southern extremity of Ceylon, a locality which must have a very different climate from Jaffna.

collecting when travelling, to bear upon the rich materials collected by his predecessors and himself. His exertions have already given him a prominent position amongst Indian botanists; and from his continued labours we hope to see the Cingalese Flora fully illustrated in an economical and botanical point of view.

2. Malabar.

We shall employ this term in its widest signification, and as usually applied by older geographers, to designate the whole of the narrow belt of country (rarely above fifty miles broad) west of the great Peninsular chain, from Goa to Cape Comorin: it thus includes the British district of Malabar, besides Canara and Kúrg to the north of it, and the kingdoms of Cochin and Travancor to the south. The eastern political boundaries of these districts correspond nearly, but not uniformly, with the crest of the mountains; and though some parts of the latter are included politically in the provinces of Mysore and the Carnatic, we shall consider them all as one province botanically.

Malabar is in general hilly and mountainous; a narrow strip of low land borders the sea, frequently intersected by long sinuous salt-water creeks, and covered with Cocoa-nuts; the hills which are thrown off as spurs from the main axis often reach the sea and dip suddenly into it: they enclose well cultivated valleys, and, though generally low to the west, they rapidly rise to the east, where they join the chain.

The climate of Malabar is characterized by extreme humidity, and an abundant rain-fall during the south-west monsoon, when the temperature seldom rises above 75° (the mean of the year being 81°). In many parts the rains commence as early as the middle of March, but rarely become heavy till May, continuing thenceforward incessant till October, and depositing more than one hundred inches on the coast. In the extreme south the rain-fall is less considerable; at Quilon 77 inches, and at Trivandram 65 inches, probably from the

narrowing of the land and the lower elevation of the mountains. The humidity, however, continues excessive. At Cape Comorin the amount of rain is only 30 inches. To the northward, in Canara, the climate is drier, especially in winter, and the hills are less elevated. During the north-east monsoon, from January to April, which includes the hottest season of the year throughout the province, irregular winds and showers prevail everywhere, except opposite Coimbator, where, from the great depression in the mountains, dry winds are at that season not unfrequent.

From the humid character of the Malabar climate, its luxuriant vegetation might be inferred. Hamilton tells us that it resembles Bengal in verdure, but has loftier trees and more Palms: the shores are skirted with Cocoa-nuts, and the villages surrounded with groves of Betel-nut Palms and Talipots. *Vateria Indica,* a noble Dipterocarpous tree, is abundantly planted in many parts; Cassia, Pepper, and Cardamoms flourish wild in the jungles, and form staple products for export. The fact that the Pepper is cultivated without the screens used in other parts of India, to preserve a humid atmosphere about it, is the best proof of the dampness and equability of the climate. The low valleys are richly clothed with rice-fields, and the hill-sides with millets and other dry crops, whilst the gorges and slopes of the loftier mountains are covered with a dense and luxuriant forest.

The mass of the Flora is Malayan, and identical with that of Ceylon, and many of the species are further common to the Khasia and the base of the Himalaya. Teak is found abundantly in the forests, but the Sandal-wood occurs only on the east and dry flanks of the chain. Oaks and *Coniferæ* are wholly unknown in Malabar, but the common Bengal Willow (*Salix tetrasperma*) grows on the hills. *Gnetum* and *Cycas* both occur, the former abundantly.

The mountain-chain which forms the eastern boundary of Malabar, separating it from Mysore and the Carnatic, has, except on the eastern slopes of the most lofty parts, a very

humid climate, and is therefore most appropriately noticed here. It attains its greatest elevation to the southward, and is broken up, by considerable depressions, into two or more separate masses, of which the southernmost may be called the Travancor range, whilst to the northward it is continued as the Nilghiri, Kúrg, and Nagar mountains.

TRAVANCOR.—The mountains of Travancor form an isolated mass at the extreme south of Malabar, which they separate from the districts of Tinnevelly and Madura, in the Southern Carnatic. They are completely cut off from the mountains on the north (Nilghiri) by a remarkable depression, in 11° N. lat., which is fifteen miles wide, and is occupied by the western portion of the district of Coimbator. The Travancor group of mountains thus presents a striking analogy to the island of Ceylon in position and outline. The main chain runs southward for 150 miles to Cape Comorin, with occasional deep depressions, and terminates in a bold precipitous mass, 3–4000 feet high, within three miles of the Cape itself. The Travancor mountains are loftiest at the extreme north of the district, where thèy stretch east and west for sixty to seventy miles, separating the districts of Dindigal and Madura, and rising into peaks of 8–9000 feet, which overhang the plain of Coimbator; and they retain an elevation of 5–6000 feet throughout their extent to the southward. They are generally very precipitous, and undulating or rounded grassy ridges seem to be of common occurrence at 6–7000 feet. Of the deep depressions that intersect the Travancor range, and by which communications are kept up between the districts which it divides, that of Courtalam, in 9° N. lat., is a well-known botanical station, which, though on the eastern or Carnatic side, from its peculiar form and situation, is under the influence of the south-west monsoon, and enjoys, together with the rest of the province, a deliciously cool and equable climate. Notwithstanding the perennial humidity, the rainfall at Courtalam is only 40 inches; on the hills around, however, it is doubtless much greater. The Pulney or Palnai

mountains west of Dindigal, the Animalaya south of Coimbator, the Shevaghiri mountains south-west of Madura, and the ranges near Courtalam, are all well-known as the scenes of Dr. Wight's indefatigable labours, which have extended to Cape Comorin itself in this direction.

There are few botanical features of Travancor not common to both Ceylon and Malabar in general. Nutmegs, coffee, and cinnamon flourish at Courtalam. The remarkable Palm, *Bentinckia,* so common on its mountains, is however not known in Ceylon. The other Palms are *Caryota urens,* an *Areca, Phœnix farinifera,* and one or two species of *Calamus.*

NILGHIRI AND KÚRG MOUNTAINS.—To the north of the Coimbator valley, this part of the peninsular chain rises abruptly to 8000 feet elevation as the Nilghiri range, and is continued northward as the mountains of Kúrg at nearly the same elevation. Below 6000 feet they are steep and densely wooded; above that they form undulating grassy table-lands, with scattered bushes and copsewood, from which low sloping hills arise, of which Dodabetta, the loftiest of the range, attains 8429 feet.

To the west and south, the Nilghiri mountains are precipitous; to the east, long transverse ranges covered with dense forest are given off, enclosing the lofty valleys of Mysore.

The rain-fall, which is excessive to the westward, is much diminished before reaching the axis of the chain: at Dodabetta it is 100 inches; and at Utacamand only 64 inches. The seasons are uniform throughout the year, the cold never being extreme, though frosts do occur in clear winter nights. The following abstract (which we borrow from Gardner) will afford a few data as to the temperatures of certain positions and elevations:—

	Alt.	Mean temp.
Dinhetty	6166 feet	64·0
Kotaghery	6407 „	63·4
Utacamand	7197 „	61·0
Dodabetta	8429	56·0

The monsoon is so checked by the great elevation and breadth of this range, that its east flank partakes much of the climate of Mysore, many plants of that country ascending almost to the crest of the chain, which is therefore, as Gardner informs us, wholly unsuited to the growth of Coffee.

The ravines and shady slopes near the undulating summits of the Nilghiri hills are occupied by thickets of small trees and bushes, like those of Ceylon, but probably composed of a greater number of species, all of which are equally characteristic of similar situations in the Khasia, as *Ternstrœmiaceæ, Michelia, Symplocos, Photinia, Ilex, Eugenia, Vaccinium, Gaultheria, Myrsineæ, Rhododendron arboreum, Pittosporum, Laurineæ,* with *Rubus, Cotoneaster, Desmodium, Jasminum, Euonymus, Indigofera, Daphne, Euphorbiaceæ, Antidesmeæ,* Willow, *Melastomaceæ,* and a vast number of others. Of forms that do not extend to Ceylon, are Willow, *Gnetum, Viburnum, Lonicera, Rosa.* Balsams attain their maximum in the Nilghiri and Travancor mountains; and amongst European forms are *Alchemilla, Potentilla, Gentianeæ,* and *Labiatæ. Agrimonia,* however, which is found both in the temperate parts of India and in Ceylon, is absent from the Nilghiri.

NAGAR.—Of this district, which lies to the north of Kúrg, comparatively little is known; politically it belongs to Mysore, but its climate and vegetation appear to be identical with that of Malabar. For the most part it consists of rounded or table-topped hills, 4–5000 feet in mean elevation, often cultivated to that height, and rising in some places to upwards of 6000 feet, the portion called Bababúden Hills being said to be 5700 feet. As with all other parts of the chain, the climate of the western parts is excessively humid: the rains at the town of Nagar (or Bednor), elevated 4000 feet on a spur to the westward of the chain, are said to last for nine months, during six of which they are so heavy that the inhabitants cannot leave their houses. The eastern parts again are more level, and drier, and resemble other districts of Mysore.

North of Nagar, and near the sources of the Warda River (in 14° N. lat.), there is a marked break in the chain, which there seems hardly to rise above the level plain of Dharwar to the eastward. Here the watershed recedes further than usual from the west coast, and two considerable rivers flow in deep ravines from the immediate vicinity of Dharwar to the Western Ocean, separated by lateral spurs which run south-west from the axis of the chain.

Dr. Buchanan Hamilton was the first after Rheede to explore the botany of Malabar. Having been deputed to that province by the Government of Madras, charged with a multiplicity of duties, he does not seem to have collected largely, nor has he published any general work on the subject. Many important botanical observations of his are, however, detailed in various publications, and especially in his Commentaries on the 'Hortus Malabaricus,' which have in part only appeared in the Linnæan Transactions. To this task he brought an extensive knowledge of tropical botany and Oriental literature.

Dr. Wight's researches, in many parts of the province, are justly celebrated throughout Europe; he has personally explored the Travancor mountains as far south as Cape Comorin, the Courtalam and Pulney hills, the neighbourhood of Quilon, and especially the Nilghiri chain, which is easily accessible from Coimbator, where he so long resided as superintendent of the Government Cotton Plantations. Dr. Gardner, when on a visit to Dr. Wight, also collected in the Nilghiri chain, as did Sir Frederic Adam, and Mr. Schmid, a missionary, a few of whose plants have been published by Zeuker.

The northern district, or Canara, has been diligently explored by Mr. Dalzell, who resided for many years at Vingorla, in the Southern Concan, and made extensive journeys. A large collection of Canara and Kúrg plants was also made by Mr. Metz*, a missionary, and distributed in Germany by Hohenacker, and named by Miquel; these are partly from the

* The name of Mr. Metz should be substituted for that of Mr. Schmid at p. 69 of this Essay.

neighbourhood of Mangalore, and partly from the vicinity of Mercara in Kúrg.

The mountains of Kúrg were first explored by Captain Munro and Captain Gough, who seem to have sent many plants to Dr. Wight. Copious Herbaria were also made in various parts of the chain by our own collectors. The district of Nagar seems to have been visited by Hamilton only, on his return from Canara to Mysore: his notices of it are very scanty. Dr. Wight has further published a few plants of the Bababuden hills.

A careful comparison of much of the materials comprised in these different collections, from all parts of the chain, assures us that Malabar is comparatively well explored botanically, and that there are not many more phænogamic plants to reward the labours of future investigators.

3. Concan.

This district extends from Goa to Daman, or very nearly to the Tapti river. Like Malabar, which it greatly resembles in general aspect, it is comprised between the western ocean and the Ghats, and consists of a narrow belt near the sea with salt-water inlets, and a succession of mountain spurs. In the northern parts of the Bombay Presidency, the chain separating the Concan from the Dekhan is called the Northern Ghats, or Siadri mountains, a term which may conveniently be extended to their whole length, and which we shall thus apply when it is necessary to particularize them. Throughout the Concan they form a continuous chain of hills, interrupted, however, by deep depressions. Throughout their length, they seem seldom rugged, but to rise often into sharp or flat-topped peaks. To the east they slope gently into the plains of the Dekhan. The summits rise to the height of 4000–5000 feet, but the mean elevation is very much less. The station of Mahabaleshwar is 4700 feet. In the latitude of Daman 20½° N.), the chain begins to sink abruptly into the Tapti valley, and changes its course, or sends off a spur of considerable elevation in an easterly direction, as the Chandor hills.

This range of the Ghats is sufficiently lofty and abrupt to produce a heavy rain-fall during the south-west monsoon; between May and September this is in some parts immense, and only rivalled by that of Malabar and the Khasia hills in East Bengal. At Mahabaleshwar, it amounts to 248 inches annually. In the Southern Concan, especially in the Sawant Wari district, the rains are as heavy as in Canara. At Bombay, the rains last from June till the end of September, and the fall is only 80 inches, which is considerably less than at any point further south on the coast. At Tannah, however, the average fall is more than 100 inches. During the north-east monsoon, which blows from November till March, the climate is dry compared with that of Malabar, the change commencing rather suddenly where the mountains are lowest and most distant from the coast. At Bombay there are regular sea-breezes in the afternoon, so that the atmosphere never becomes extremely arid.

The change of climate, marked by diminished mean temperature, a lower winter temperature, and greater dryness, which accompanies the increased distance from the Equator, has a decided influence on the vegetation. The whole Concan is hence more open than Malabar, heavy forests are rarer, many tropical Malayan forms disappear, and the most moisture-loving types of vegetation linger only in the damp recesses of the mountains. A rich cultivation replaces the forest in the valleys especially, and the dense jungles are confined more or less to the lower slopes of the main chain. In the more open parts there is a remarkable mixture of African types; instead of the luxuriant *Acanthaceæ* of Southern India, there occur spiny-leaved species, similar to Abyssinian and Arabian ones. Curious *Umbelliferæ*, allied to no others in India, accompany these, as well as a great variety of forms typical of the north tropical African vegetation. The arid flora of the Dekhan, of Marwar and Sind, however, hardly enters the Concan.

The Flora of the Bombay Presidency has only lately been

diligently investigated, little having been known of it up to the date of publication of Wight and Arnott's Prodromus. The plants of Concan were first catalogued by Mr. Graham, assisted by Mr. Nimmo; these botanists seem to have been diligent workers, and were correspondents of Dr. Wight, to whom they communicated valuable discoveries.

Dr. Gibson, the energetic Conservator of Bombay Forests, has had, owing to the nature of his duties, ample opportunities of investigating the Flora of Bombay, and we are indebted to him for a considerable Herbarium. We have also had the opportunity of examining the excellent collections of Dr. Stocks, who officiated for Dr. Gibson during that gentleman's visit to Europe, and to whom we have been greatly indebted for information and assistance.

It is, however, by Mr. Law and Mr. Dalzell, that the Concan Flora has been most ably and energetically investigated. Mr. Law resided for many years at Tannah (near Bombay), and explored the Northern Concan, whilst Mr. Dalzell chiefly employed himself in the Southern Concan and adjacent province of Canara.

4. Carnatic.

In the extreme south of the Peninsula, the Carnatic extends from the eastern sea to the borders of Malabar; but further north, where the Peninsula is wider, it comprises only the sea-coast, the province of Mysore being interposed between it and the great peninsular chain. The northern part of the Carnatic is a nearly level tract, of no great width, extending from the mouth of the Godavery to the delta of the Cavery. It is not a perfect level, as a few low ridges project at intervals from the Ghats; and some isolated hills of trifling elevation occur, scattered over the surface, evidently the remnant of former continuous ranges, which have been apparently removed by aqueous action. None of these exceed a few hundred feet in height, and they exercise no material influence on the climate or vegetation. Much of the country is sandy,

and scarcely arable, and the inhabitants are in general so dependent on the periodical rains for their crops, that any deficiency in the rain-fall is followed by a bad harvest.

Throughout the northern Carnatic, the rain-fall during the south-west monsoon is trifling in amount; and as the sun's action is not mitigated by a cloudy sky during the hottest period of the year, as is the case in Mysore, the temperature from March till November is extremely high. In the middle of October or the beginning of November the north-east monsoon sets in, and with it a more or less abundant rainfall. In the end of December the rains cease, from the gradual change in the direction of the wind, which makes it less directly a sea-breeze than in the earlier part of the winter season. The mean temperature of Madras is 82°, and the rain-fall does not exceed 45 inches.

In the southern Carnatic, the district of Salem, between the rivers Penar and Cavery, which is considerably more elevated than the rest of the province, may be considered a prolongation of the most elevated part of the central platform of Mysore. The table-land of Mysore dips abruptly into the plain of Salem, which has an elevation of about 1100 feet above the sea, and contains several detached masses of hills scattered over it, all rising to very considerable elevations. Of these, the most lofty are the Shiwari hills, which rise a few miles north-east of the town of Salem, in a range of densely wooded flat-topped hills. The mean height of the table-land on their summits is about 4600 feet, but the highest peak rises to 5260 feet. The Salem district, from its position opposite the Coimbator gap, and from the influence of the considerable masses of high land just mentioned, is rather more rainy than the northern Carnatic. The south-west monsoon sets in early in June, and short but heavy and frequent showers continue till September. Towards the end of October, the north-east monsoon brings a return of showery weather, with a cloudy sky. This continues till the middle of December, when the rains cease in consequence of the gradual change of the direction of the wind from north-east to due north.

The district of Coimbator has, like that of Salem, so many peculiar features, as to call for a special notice. It lies opposite the great gap in the Peninsular chain already so often referred to, and is conterminous with Malabar. Between the southern slopes of the Nilghiri mountains, and the northern face of those of Travancor, there is interposed a space of about thirty miles in width traversed by low hills. Across that depression, the south-west monsoon has almost a free passage to the eastward; but the great elevation of the mountains on both sides, and the absence of any considerable hills in the district, cause the monsoon wind to pass over without depositing much of its moisture, and, though the climate is humid, the rain-fall is very trifling. During the north-east monsoon again, the high hills of eastern Mysore and those of the Salem district intercept a considerable portion of the moisture which would otherwise reach this district. Coimbator is thus remarkable for the very small annual amount of rain, which is not more than twenty-one inches.

The district of Tanjor, which comprises the delta of the river Cavery, appears to present no remarkable features beyond those common to all tropical deltas. Its climate is more humid and cool than the remainder of the Carnatic, chiefly owing to the swampy soil.

The extreme southern portion of the Carnatic, including the districts of Madura and Tinnevelly, is separated from the remainder by a lofty transverse range of mountains, which runs from west to east, passing to the south of Dindigal. These mountains, which at their eastern extremity, where they are called Pulney (Palnai) mountains, are 6000–8000 feet in height, gradually diminish in elevation to the eastward. About five miles south of Dindigal the Serroo Mullay (Serú Malaya) hills, rise to 3500 feet, and the range sinks, about twenty miles to the eastward of Dindigal, into the plain of the Carnatic. This range of hills insulates in a very remarkable manner the districts to the south of it, which are sheltered from the south-west monsoon by the high mountains of Travancor on the west, and from the north-east monsoon by this

range to the north, and by the island of Ceylon to the east. We have, therefore, in the southernmost part of India, in a latitude between 8° and 10° N., a hot, arid climate, resembling that of Egypt, like which it produces the best quality of senna and cotton, and many wild plants characteristic of the Egyptian Flora, which avoid humidity, and are not known elsewhere in the Peninsula. Of this, two remarkable instances are *Cocculus Leæba*, and *Capparis aphylla.*

As a whole, the vegetation of the Carnatic is neither rich nor varied. The climate being very arid except during the north-east monsoon, the humid flora is entirely absent. There is no forest, except on the flanks of the higher mountains, which bound the province on the west, or rise from its plains; and there the vegetation resembles that of the drier parts of Ceylon or of the Mysore hills. The shrubby flora of the open plains consists chiefly of *Capparideæ, Rhamnaceæ, Acaciæ,* and spinous *Rubiaceæ, Alangium, Azima, Carissa* and *Calotropis gigantea, Ehretia buxifolia, Gmelina, Salvadora, Antidesma, Pisonia,* and such like shrubby plants. The only Palms are a *Calamus* and *Phœnix,* besides the commonly cultivated *Cocos, Borassus* (which characterizes dry countries), and *Areca*. Along with these, grow many shrubs which are spread over the whole of the drier parts of India, as far as the Himalaya. Many of the annual plants have an equally wide range, especially those of the rains, which are scarcely different from those of the Gangetic valley. As there is no winter, there are no northern types found in any part of the Carnatic.

The vegetation of the hilly parts of the Carnatic has yielded no peculiarities. Most of the hills are of too trifling elevation to exhibit any marked difference of mean temperature; and even the Salem range, from the isolated position of its masses, appears to present fewer peculiar features than more continuous mountain masses of even less elevation. The flanks are covered with dense bamboo jungle, and the summit is bare and grassy, except in ravines and along the streams. A detailed

account of the flora of their summits is, however, a desideratum.

The vegetation of the plain of the Carnatic has been investigated by so many persons, that it is now thoroughly well known. The earliest peninsular botanists were the Danish missionaries, who originally settled at Tranquebar; and most of the collectors who have visited the peninsula have traversed the Carnatic *en route* to the interior. It is therefore unnecessary to enumerate the names of all those who have botanized there.

5. Mysore.

The province of Mysore is bounded on the north by the Dekhan, on the west by the mountain axis of the peninsula, and on the east and south by the low country of the Carnatic. It is usually described as a table-land enclosed between the western and eastern Ghats; a form of expression which has doubtless originated in the fact that a considerable rise is made in entering the province from either side.

The Western Ghats, as we have already fully explained, form a chain extending in a direction parallel to the western ocean; and Mysore, which occupies the eastern and more gentle slope of these mountains, contains the upper part of the basins of the Cavery, Penar, and Tungrabudra rivers, all of which discharge their waters into the Bay of Bengal.

Through the centre of this elevated tract, nearly in the parallel of Mangalor and Madras, is situated the watershed which separates the first of these rivers from the two latter. This is not an elevated ridge, but a rounded and often scarcely perceptible swelling, usually undulating very gently, but rising at intervals into rugged masses often more than a thousand feet above its mean elevation. The highest summits in Mysore (except in the district of Nagar) are situated on this line, and are north-east and north of Bangalor, where several peaks rise to 4000 feet, and one to 4500 feet. To the north of this range the elevation is less considerable, but the ap-

pearance of the country is the same. The rivers which flow towards the Kistna are separated by spurs of a high table-land, rarely rising into hills, so that the country appears nearly flat, except to the eastward, where it dips suddenly into the plain of the Carnatic. The elevation of Bellary is 1600 feet; Karnúl is about 1000 feet; and Cadapah, in the gorge of the Penar, where it issues from among the mountains, is only 500 feet above the level of the sea.

Another spur from the great peninsular chain forms the southern boundary of the province, separating the district of Coimbator and the basin of the Bhowani river from the upper basin of the Cavery. This range, which attains generally an elevation of nearly 4000 feet, extends in an easterly direction from the eastern slopes of the Nilghiri.

Between these two watersheds, the table-land of Mysore forms a gently undulating plain, sloping downwards, from 4000 feet at the base of the mountains, to 3000 at Bangalor, and 2400 at Seringapatam on the banks of the Cavery.

The highlands of Mysore sink everywhere abruptly into the plain of the Carnatic, except where the great rivers debouche; and the extremities of the broad flat-topped ranges which form the table-land, when viewed from a little distance, present the appearance of a continuous range of hills parallel to the coast-line, commonly known as the Eastern Ghats.

The districts of Bellary, Karnúl, and Cadapah, which occupy the northern slope of the central range of Mysore, and the higher parts of the basin of the Tungabudra and the Penar, are usually excluded from Mysore, being known as the Ceded Districts, because they were transferred from the kingdom of Mysore to the Nizam after the war in 1800, and afterwards made over to the British Government in lieu of a money-payment. As they present no physical or botanical features which would make it desirable to consider them as a separate province, we shall include them under the general name of Mysore, of which the Kistna will therefore form the northern boundary.

The climate of Mysore is much drier than that of Malabar, because the greater part of the south-west monsoon is intercepted by the lofty ranges of the Nilghiri and of Kúrg. The summer heat is however very moderate, partly on account of the elevation of the table-land, and partly because the proximity of the high central chain, which is very much cooled, produces a great amount of cloudy weather throughout the summer months. In winter the north-east monsoon is little felt in the interior, the greater part of the discharge from it being on the coast and on the line of Ghats at the border of the table-land. The winter temperature is therefore not much less than that of summer, so that the climate is very equable. The mean temperature of Bangalor is 74°, and the rain-fall 35 inches; at Bellary the rain amounts to only 22 inches. To the northward, the north-east monsoon is very little felt in the western districts, but at Cadapah there is generally heavy rain in November, and the remainder of the winter is dry. This place is so low, and so far from the mountain axis and the west coast, that the south-west monsoon is scarcely felt, even by the formation of clouds, though strong westerly winds prevail at that season. Cadapah is hence one of the hottest and most unhealthy parts of the Madras Presidency.

The vegetation of Mysore, like that of the Carnatic, is rather scanty. The level surface of the table-land is frequently very barren, and the hills are often bare or covered with low scrubby jungle. In the western part of the province, the eastern slopes of the central chain are clothed with dense forest, and the humidity is there very considerable, and the vegetation in consequence more varied, but approaching closely to that of Malabar.

The steep slopes of the eastern Ghats, which are powerfully affected by the north-east monsoon, are also in general densely wooded. Characteristic trees and shrubs are *Isora, Cedrelaceæ* and *Meliaceæ, Erythroxylon, Dipterocarpus, Myrtaceæ, Acacia Lebbek, Cassia Fistula, Pterocarpus, Butea frondosa,*

Lagerstrœmia parviflora, Terminalia, Conocarpus, Nauclea cordifolia, Diospyros, Teak, *Santalum album, Alnus integrifolia, Trophis aspera, Bambusa,* etc. etc.

The absence of winter, and the great heat of the dry season from December to June, give a predominance to arid types, especially to those which have been already indicated as intolerant of cold. Few palms are indigenous, except in the dense western forest. *Phœnix sylvestris,* however, occurs, and *Areca Catechu, Cocos,* and *Borassus* are cultivated extensively. During the more humid summer season a number of Balsams spring up; a genus unknown at that season in the hotter and drier Carnatic.

Our earliest knowledge of the plants of Mysore is due to the indefatigable Buchanan Hamilton, in whose travels many details regarding the aspect of its vegetation will be found. It has since been partially investigated by many botanists, in particular by Heyne and by Wight, but a detailed list of its plants is still a desideratum.

6. Dekhan.

The Dekhan embraces the whole of the country between the Kistna and the Godavery, except a very narrow belt along the Bay of Bengal, which is included in the Carnatic. To the west it is separated from the ocean by a narrow strip of land, the Concan, the crest of the mountain axis forming the (physical) boundary between the two provinces. To the north, a low range separates it from Khandesh, and further east the Godavery forms an artificial boundary between it and Berar.

The mountain-chain which forms the axis of the peninsula is considerably lower in its northern half than further south. North of Nagar, it appears to dip rather abruptly, so that between Goa and Belgaum it is very much depressed, and presents scarcely any perceptible elevation above the surface of the table-land, which is there 2500 feet. Further north, the elevation of the table-land gradually diminishes, notwithstanding the increasing width of the continent. At

Púnah it is 1800 feet, and the peaks of the chain attain an elevation of 4–5000 feet, but they are separated by great depressions. The table-land of the Dekhan forms the watershed between the basins of the Kistna and the Godavery, and has an average elevation of from 1800 to 2000 feet, with an undulating surface, but no mountains rising much above the mean level. Hyderabad is 1672 feet, the Cantonment of Secanderabad, close by, 1837 feet, and a hill near, 2017 feet above the level of the sea. The valley of the Godavery is of course considerably lower. The surface of the table-land, which is generally open, with little forest, but much low jungle, is at one season richly cultivated, but during the remainder of the year extremely arid and burnt up.

The abrupt escarpment of the western Ghats condenses so much of the moisture of the south-west monsoon, that the summer rains in the Dekhan are very moderate in amount, and the north-east monsoon is so much a land-wind, that but little rain falls during the cold season. The rain-fall at Hyderabad and Jaulnah averages about 43 inches; at Satara (2300 feet) it is 36 inches. The mean temperature of Púnah is 77°, and the rain-fall 24 inches. This is the average rain-fall throughout the north-western part of the district, close to the crest of the Ghats, but the amount is greater to the eastward.

Along the crest of the Ghats, the hilly tract known as the Máwal possesses a very different climate and aspect from the remainder of the Dekhan, bearing more resemblance to the Concan. This is due to its greater humidity; the depressions of the watershed, here as elsewhere, allowing the moisture-laden wind to pass to the eastern part of the chain for a considerable distance. In this district the surface is perennially green, and the vegetation much more luxuriant than further east. In the western parts of the district of Belgaum this tract is especially marked, as the depression of the mountains is there greater than elsewhere. At Belgaum the rain-fall is 50 inches, and at Dharwar 39 inches. These numbers,

however, afford only a very faint indication of the degree of humidity.

The vegetation of the plain of the Dekhan is not very different from that of Mysore. The flora is not extensive, the great drought of the hot season being unfavourable to vegetation. The earliest collection of its plants was made by Colonel Sykes, and is now in the possession of the Linnean Society. In Graham's Catalogue there is an enumeration of all the plants known to him, and its flora has recently been explored by Dr. Gibson and Dr. Stocks. The green hilly tract bordering upon the Concan, being more elevated, as well as more humid than the remainder of the district, presents a peculiar vegetation. Some of its plants are apparently confined within very narrow limits, and are not known elsewhere in India.

7. Khandesh.

This province occupies the lower part of the valley of the Tapti river, and is enclosed on the north by the Satpura range, a branch of the Vindhia, which has an elevation never exceeding 2500 feet, and is often much lower. To the south, the Ajanta range, separating Khandesh from the basin of the Godavery and the district of Aurangabad in the Dekhan, is even less elevated, rarely attaining so great an elevation as 1800 feet. To the east this province is separated by no very definite boundary from the Ellichpur district of Berar.

The valley of Khandesh is, in general, a level plain, rising gently towards the mountains on both sides. Occasional flat-topped hills are scattered over the surface, and the slopes of the Ajanta and Satpura ranges are covered with dense jungle.

The rainy season, in Khandesh, is the south-west monsoon, commencing in June. The rains are heavy and long-continued, but we have not been able to ascertain their exact amount, nor have we any definite knowledge of the flora of the province.

8. Berar.

The province of Berar includes the districts of Ellichpur

and Nagpur, the former occupying the upper part of the basin of the Tapti, and that of its tributary the Púrna, the latter situated on a tributary of the Godavery, and therefore separated by no well-defined boundary from the north-eastern part of the Dekhan.

To the north, Berar is separated from the valley of the Nerbada by the continuation of the Satpura range, gradually increasing in height to the eastward, and attaining an elevation of 3000 feet, south of Hosungabad. The Rev. Mr. Clarke states that Chouragadh, the highest peak of the Mahadeva hills, north of Nagpur, rises to 4200 feet. The Ajanta range, on the contrary, is very inconspicuous to the eastward, as the plain on both sides slopes up to its crest; but the Gawilgarh hills, which separate the Púrna and Tapti rivers, rise in peaks to a height of 3000 feet. The eastern boundary of Berar corresponds pretty closely with the watershed of the Mahanadi river, the elevation of which is unknown. Berar is, in general, level, but the plains are separated by low ranges of naked table-topped hills, most numerous in the northern portion. Nagpur is 900 feet above the level of the sea, and Ellichpur may be conjectured to be very little more.

The rains in Berar are of short duration, but more considerable in amount than in the Western Dekhan. At Nagpur, the fall is 40 or 50 inches between June and October. The remainder of the year is dry and intensely hot, the mean temperature of Nagpur being $81\frac{1}{2}°$. The vegetation is probably identical with that of the Dekhan, but the province is botanically unknown.

9. Orissa.

Under this name we include the whole basin of the Mahanadi river. On the north, this province is bounded by the crest of the Vindhia, on the north-east by a spur descending thence towards the sea near Balasor, on the south-east by the sea, on the west by the watershed separating the Mahanadi from the tributaries of the Godavery, and on the south-west by that river from Chandah to the sea.

The physical structure of Orissa is very imperfectly known. It is in general hilly, and the ranges have probably pretty uniformly a maximum elevation of 3000 feet. They are often table-topped ridges, separated by flat broad valleys, but perhaps most frequently spreading out into elevated platforms. The table-land of Sirgujah and Chota Nagpur, which forms the northern part of the province, is an expansion of the southern branch of the Vindhia, here forming the watershed between the Mahanadi and the Sôn. It is said to have a mean height of 3000 feet, and to be covered with dense forest. The ridge which separates it from Berar presents probably, in like manner, an extensive platform of moderate elevation.

Throughout Orissa, the hills approach within a distance of the sea which varies from twenty to fifty miles, and at Vizigapatam and Ganjam they advance close to the shore. These hills (like the Ghats of Mysore further south) terminate very abruptly, and are separated from the sea by an alluvial belt, which skirts their base and advances between the different spurs, so as to form richly-cultivated valleys among the hills. The Ghats generally rise abruptly to an elevation of 1500 or 2000 feet. Their flanks are covered with dense forest, as well as the flat tops of the outer and more humid portions of the spur, but in the interior these spread out into bare table-topped ridges.

The Mahanadi being the principal river of Orissa, its valley is the lowest part of the province. It is navigable for large boats as far as Boad, a hundred miles above Kattak. It is then hemmed in for some distance by mountain-spurs, but higher up its valley expands into the level plain of Sambalpur.

The table-land of Umerkantak, in which the rivers Nerbada and Sôn take their rise, as well as one branch of the Mahanadi, is an elevated tract of dense jungle, traversed only by narrow paths, and quite removed from the great line of traffic across the continent. It is said to attain an elevation of 4500 feet; but the observations upon which this statement

rests are of doubtful accuracy. Umerkantak was visited many years ago by Dr. Spilsbury, and it may be gathered from the narrative of his visit that the reports which ascribe to it an elevation of 7–8000 feet are greatly exaggerated.

The climate of Orissa is peculiar. Influenced by the hot plains of Northern Hindostan, the summer monsoon blows from the south or south-east, as in Bengal, instead of from the south-west, which is its direction in the Carnatic. It is therefore a sea-wind, and brings with it much humidity, which is deposited on the outermost hills. The coast and outer ranges are therefore extremely humid, but the valleys of the interior are much more dry. During the winter monsoon, the great heat of the dry plains of Nagpur and the Dekhan causes a sea-breeze to blow, during the day at least, all along the coast of Orissa. The hills are therefore, at this season also, damp and humid, though the rain-fall is not great in amount. In April and May there are occasional land-winds, before the heating of the great Gangetic plain changes the direction of the south-west monsoon. We possess no register of the rain-fall on the mountains of Orissa, where it would probably be found very large in amount. Along the coast the fall is much less considerable, being 50 inches at Kattak, and gradually diminishing to the southward. At Masulipatam it is only 34 inches.

The forests which cover the slopes of the outer ranges are very dense, and, though not equal in luxuriance or variety to those of Malabar and Malaya, they are richer in forms than those of Mysore, many Malabar plants not found in the Carnatic or on the Eastern Ghats recurring in these more northern jungles. Thus the wild Pepper is found there abundantly, with numerous *Zingiberaceæ* and Orchids, *Arenga saccharifera*, and perhaps *Caryota*, but apparently no other palm. Species of *Dillenia, Leea, Mimusops, Bassia, Roxburghia*, etc., also occur. The forests which cover the mountains of the interior are much drier, and are separated by open valleys, more or less under cultivation.

The botany of the coast of Orissa, and that of the forests of

the Ghats, has been investigated by Roxburgh, who, during the earlier part of his Indian career, resided at Samalcotah in the northern Circars, by which name the district is usually referred to in the 'Flora Indica' of that distinguished botanist. Dr. Russel's collections were also chiefly from the same district. The vegetation of the interior of the province is quite unknown, except from a few notices in Major Kittoe's journey to the Sambalpur valley.

10. Bahar.

The boundaries of the ancient province of Bahar have no doubt varied at different epochs, and in modern times the name is understood in a great variety of senses, being restricted at one time to a small judicial district, and at other times extended so as to include the whole of the western part of the lower provinces of the Bengal Presidency. Its employment in an arbitrary manner can therefore be productive of no inconvenience, so long as it is accurately defined. We shall therefore, in our present work, understand under the name of Bahar the whole of the northern slope of the eastern portion of the Vindhia mountains, from the borders of Bandelkhand (or rather Rewah) and Malwah to the Gangetic plain. In this way it is separated from Orissa by the watershed of the chain, and includes the districts of Palamow and Ramgarh, as well as the lower half of the valley of the Sôn.

The eastern portion of the Vindhia chain, as we have seen, is a spreading table-land, and the spurs which it sends down to the northward are similar in nature to those which run south, and separate the different valleys of Orissa. There is a great want of authentic information regarding the elevation and even the physical features of these wild and little-known countries. The elevated table-land of Chota Nagpur is said to have an average height of 3000 feet; and further west, towards the borders of Sirgujah, the surface is perhaps a little higher. The plain of Hazaribagh has a mean height of about 1800 feet; and twenty or thirty miles further east, that out of

which the mountain Parasnath (an isolated peak) rises suddenly to an elevation of 4500 feet, is 1200 feet high. Parasnath is the highest known elevation in the province, though perhaps in the unknown districts to the westward the hills may rise as high or higher.

The flat-topped spurs of the Vindhia sink abruptly into the valley of the Sôn, which is bounded on the west by a line of cliffs rising 1000 feet or more above the bed of the river. Further east, the elevation is less considerable, and the table-land is broken up into a rugged hilly country, the last spurs of which approach close to the Ganges at Monghir, Bhogilpur, and Rajmahal.

The climate of Bahar resembles that of the interior of Orissa. During the south-west monsoon, from June to October, there is a moderate rain-fall, the amount of which has nowhere been determined with accuracy. Throughout the remainder of the year the province is very arid, and subject to hot winds, which blow over it from the dry plains of Rajwara and the upper Gangetic valley. At the same time, perhaps from the gentle slope, and consequent imperfect drainage in a densely wooded country, the forests (like those of Orissa) are extremely unhealthy, even in the dry season, so that Europeans cannot penetrate into their recesses, except at the height of the cold season, without great risk to life.

In all parts of the mountain districts of Bahar the open valleys are more or less cultivated, but, with rare exceptions, the soil is poor and the population scanty, and the crops very indifferent. The surface of the platforms between the valleys, when level, is often rocky and bare, but, when undulating, is covered with bush jungle, in which bamboo is very abundant. The steep slopes of the hills are covered with dense forest. The flora is very similar to that of the hills which form the eastern Ghats between the Carnatic and Mysore, or to that of the drier slopes of the central Himalaya.

Cedrela Toona, Vatica robusta, Buchanania, Semecarpus Anacardium, Cassia Fistula, Butea frondosa and *parviflora,*

erect and scandent *Bauhiniæ*, *Acaciæ*, especially *A. Catechu*, *Conocarpus*, *Terminalia*, and *Nauclea cordifolia* are characteristic forms. All of these extend likewise to the Himalaya, but a few species have their northern limit in the mountains of Bahar and Bandelkhand, such as *Cochlospermum Gossypium*, *Chickrassia tabularis*, *Swietenia febrifuga*, *Boswellia thurifera*, *Hardwickia binata*, and *Bassia latifolia*, which are all more or less abundantly distributed throughout the province. No palm is indigenous but *Phœnix acaulis;* for the common *Calamus* of Bengal, which extends north to the base of the hills at Monghir, is not found in the interior.

The flora of the mountain Parasnath, an isolated peak which scarcely attains a temperate elevation, presents few peculiar features. The upper part is however more humid than the base, and plants indicative of a moist climate, such as parasitical *Orchideæ*, Ferns, *Arum*, and others, make their appearance in small numbers. The temperate forms, *Berberis*, *Clematis*, *Thalictrum*, etc., are all Himalayan species, but most of them are widely diffused plants, extending also to the peninsula. *Vernonia divergens*, common near the summit, occurs also in Bandelkhand, and is equally abundant throughout the drier hills of the peninsula.

The Sôn valley in climate and vegetation is identical with the drier parts of the upper Gangetic valley, or the plains of Rajwara; and the low Kaimur (Kymore) range, to the north, exhibits a continuation of the features of the elevated platforms of Bandelkhand.

A part of Bahar was explored by Dr. Buchanan Hamilton, who made considerable collections in the Monghir and Rajmahal hills, and elsewhere among the mountains. Dr. Hooker also visited parts of it, but not at a favourable season; and a list of its plants has been published by Dr. M'Clelland in his geological report. It is probable that the greatest variety of form is to be met with in the more eastern hills, which, from their proximity to the Bay of Bengal, are more humid, and that to the westward the flora approaches more and more to that of the drier parts of the peninsula. *u*

11. Bandelkhand.

The district of Bandelkhand, including the small state of Rewah, which has the same physical features, occupies the northern slope of the Vindhia range, from the borders of Bahar on the east to Gwalior on the west. The watershed of that range is included within the province of Malwah, but long, flat-topped spurs descend towards the Jumna, separating the broad valleys of numerous rivers which flow northward. A little east of Gwalior these spurs extend almost to the Jumna, but further east they recede from the river, and, when viewed from the northward, appear to form an amphitheatre of precipices, so as to give the plain of Bandelkhand the appearance of a vast bay of the sea surrounded by sandstone cliffs, which again advance almost to the river not far from Mirzapur. The greatest width of the plain is about thirty miles, and near the hills many scattered insulated rocks occur, behind which the surface rises in a succession of steps, separated by level platforms, to the height of 2000 feet, whence it slopes gradually up to the watershed of the Nerbada, the average elevation of which is perhaps 2500 feet.

The plain of Bandelkhand near the Jumna is fertile and well cultivated, but the interior is generally barren, except in the valleys. Many lakes, which are all partly artificial, diversify the surface, and the hills are covered with low jungle. Its seasons are those usual in northern India. The rains commence in June and terminate in September, but, from the central position of the province, they are less heavy than in Malwah. The dry season is intensely hot, and there is a well marked cold season.

For our knowledge of the vegetation of Bandelkhand, we are mainly indebted to Mr. Edgeworth, who has published* a catalogue of the plants of the district of Banda. He enumerates 605 species of phænogamous plants; few of these differ from those common in the Dekhan and Gangetic plain, and the hill species are mostly common in the subtropical Hima-

* In the Journal of the Asiatic Society of Calcutta.

laya. The forests on the slopes of the higher hills are less luxuriant than in Bahar, and consist of fewer species; but *Mimusops Indica, Bassia latifolia, Cochlospermum Gossypium, Ailanthus excelsa,* and the Teak, have here their northern limit, as well as *Oxalis sensitiva, Sutera glandulosa,* and *Trichodesma Zeylanicum,* among herbaceous plants. The limited extent of the flora shows the dryness of the climate, which is also indicated by the occurrence of a few shrubby species typical of the dry flora: these are, *Capparis aphylla* (*Sodada* of Forskål), *Niebuhria oblongifolia, Althæa Ludwigii, Balanites Ægyptiaca, Alhagi Maurorum, Salvia pumila,* and *Tecoma undulata.* Several of these however occur equally in the Dekhan, so that the Sindhian and Arabian types are very few. No palms are indigenous, and Mr. Edgeworth's list includes very few ferns, and only one epiphytical orchid.

12. Malwah.

Under this name we propose to include the whole of Central India, from Mandlah and Saugor to the borders of Gujerat. It thus comprises the whole of the basin of the Nerbada east of Gujerat, as well as the higher parts of the Vindhia hills to the north of that river, and is bounded on the south by Khandesh and Berar, on the north by Rajwara and Bandelkhand, on the west by Gujerat, and on the east by Bahar.

The Nerbada rises on the table-land of Umerkantak, the elevation of which is variously estimated at 3500–4500, or even more, feet. In the upper part of its course the river flows among low ranges of hills on the surface of the platform. Below Jabalpur its valley forms a deep excavation in the general level of the table-land of Central India, and is bounded on both sides by rugged hills, which often hem in the river pretty closely. The Satpura range on the south has a mean elevation of about 1800 feet, and the Vindhia, on the north, is only a very little more elevated; at Jabalpur the elevation of the bed of the river is 1450 feet, and at Mandlésir it is 700.

To the north of the lower Nerbada is situated the basin of

the river Mhai (Mhye), which discharges its waters into the Gulf of Cambay, draining the whole of the western part of Malwah. This river is not separated by any very marked watershed from the basin of the Chambal, the sources of both rivers being in low hills, scarcely rising above the level of the table-land.

The Vindhia hills descend very abruptly on the south into the valley of the Nerbada, but slope very gently to the northward. The table-land of Malwah to the north is on the whole level, without any high ranges of mountains, but its surface is diversified with small conical or table-topped hills, and occasional low ridges. The general level of the crest of *ghats*, or passages by which the roads ascend from the valley of the Nerbada, is about 2000 feet, and it is but rarely that the ridge rises to a greater elevation. Jamghat, south of Mhow, is, according to Malcolm, 2328 feet, and Shaizgarh, Royle tells us, is 2628. The gentle nature of the slope towards the north may be learned by a comparison of the elevations of Saugor (2050 feet), Mhow (2019 feet), Indore (1998 feet), Ujain (1698 feet), and Mahidpur (1600 feet), as given by Malcolm. Nimach (Neemuch) still further north, but to the west of the Chambal river, and close to the watershed separating it from the Mhai, is only 1476 feet above the level of the sea, or not more than 800 feet above Gwalior and Agra, the lowest part of the platform of the Ganges in the direction in which the Chambal flows. Bhopawer, in the Mhai basin, but close to the crest of the Vindhia range, is 1836 feet.

The table-land of Malwah is in general highly cultivated, the soil being rich and productive, the climate mild and moist during the hot season, and the surface well watered by numerous rivers and copious streamlets, all of which have their sources in the crest of the Vindhia hills. The rains, which set in early in June, with the south-west monsoon from the Bombay sea, and continue till September, are copious, especially in the southern and western parts of the province, the average rain-fall in the valley of the Nerbada being rather less than

50 inches. The cold season is delightful, and the hot season much more temperate than in the Dekhan, from the more northerly position and the greater humidity, as well as from the elevation of the table-land. Hot winds seldom blow, as the south-westerly wind sets in long before the commencement of the rainy season.

The valley of the Nerbada, being much below the average elevation of the table-land, is hotter and more humid than the latter. In many places it is well cultivated, but a great part is hilly, the spurs of the bounding ranges approaching close to the river, which is so much interrupted by rapids as to be scarcely navigable. The low hills are usually covered with bush-jungle, and the slopes of the more elevated ranges are clothed with much dense forest.

The flora of Malwah is scarcely known. The forests of the valley of the Nerbada may be expected to present a considerable amount of variety, but the climate and physical features do not differ sufficiently from those of Khandesh on the one hand and of Bahar on the other, to lead us to expect much novelty. Griffith has described a few remarkable new forms in a paper in the Journal of the Asiatic Society.

13. Gujerat.

The province of Gujerat separates readily into three divisions, which are very distinct in physical features. These are—1. The peninsula of Katiwar; 2. The alluvial plain along the Gulf of Cambay, from the Tapti to the Gulf of Kach; 3. The lower slopes of the Vindhia, where they dip into the plains.

Katiwar is a mountainous district traversed by two parallel ranges of hills, running east and west, which seem to be connected by a north and south axis corresponding in direction, as has been already observed, with the Arawali range. These hills, which rise into peaks about 2000 or 2500 feet in height, make the southern part of the peninsula much more humid than the northern, which participates in the climate of Sindh.

The alluvial plain through which the great western rivers debouche into the Gulfs of Kach and Cambay is perfectly flat, and in many places fertile and richly cultivated. Its seasons are very similar to those of the Concan, but a good deal less rain falls. At Baroch the average fall is about 33 inches, at Baroda it is 31 inches, at Ahmedabad only 16, and probably considerably less to the north and west of that place, where the plain is continuous with the desert of Marwar. There are occasional hot winds from the north-east and east, and the cold and hot seasons are similar to those of lower Sindh.

The hilly district of Bariah, at the western extremity of the Vindhia, participates in the general features of the lower part of the valley of the Nerbada. The hills are densely covered with forest, and very unhealthy for a considerable part of the year, especially after the close of the rainy season. The rain-fall is probably much greater than in the plain of Gujerat.

The district of Kach (or Cutch), which is separated from Katiwar by the Gulf of Kach, a narrow arm of the sea, from Sindh by the most eastern branch of the Indus, and from Marwar by the *Run* (a very singular saline and more or less marshy plain, in which the river Lúni loses itself), has a very similar climate to the peninsula of Gujerat, being like that traversed by a range of hills running from west to east. It may therefore (for our purposes) with more propriety be considered a part of Gujerat, than to belong to Sindh, to which physically as well as politically it is more nearly related. The northern districts of both Kach and Katiwar, being screened from the rain-bringing winds by the hills, are extremely arid.

Our knowledge of the vegetation of Gujerat is entirely derived from Dr. Gibson's excellent paper in the 'Bombay Medical Transactions.' On the open plain there is a very rapid transition, in advancing northward, from the Conçan vegetation to that of Marwar and Sindh. Between the Tapti and Nerbada this is already well marked, and north of the latter river the Sindh vegetation of stunted *Acaciæ* and *Capparis aphylla* predominates. The forest which skirts the base of

the mountains is the same which prevails all over India in those hilly districts in which there is a moderate rain-fall between June and September, and dry weather for the remainder of the year. The moisture-loving types of Malabar and the Concan do not occur, and the common trees are *Butea frondosa, Acacia Catechu, Cassia Fistula, Careya arborea,* and all those trees which are common in the tropical parts of the middle Himalaya. The same vegetation extends northward along the west face of the Arawali range, and probably on the Katiwar hills. In the valley of the Nerbada, which is more humid, a more varied flora will probably be met with.

14. Sindh.

The province of Sindh extends from the sea on the south to the borders of the Panjab on the north. Westward it is bounded by the mountains of Beluchistan, and on the east it is continuous with the desert of Marwar. Sindh is an alluvial plain watered by the various branches of the Indus. For the most part it is perfectly level, but a few low hills (spurs from the Beluch mountains) here and there, as at Rori, Hyderabad, and Karachi, advance close to the Indus.

The climate of Sindh is perfectly arid, little or no rain falling at any period of the year. Now and then, however, exceptional seasons occur, when heavy showers fall at intervals, especially at the commencement of the south-west monsoon, at which time there is a considerable rain-fall in the mountains of Beluchistan and Afghanistan. The average rain-fall of Sindh is not more than four or five inches, but occasionally upwards of twenty inches of rain have been registered. Even with this amount of rain, however, the climate is so dry that the air does not remain humid for any length of time, the storms being transitory in duration. The heat is therefore very great, and the mean temperature probably as high as anywhere in India.

Though extremely fertile where irrigation is practicable, Sindh is, in consequence of the great dryness of the air, naturally sterile. There is no forest of large trees; and though

extensive tracts near the river are covered with dense jungle, chiefly of *Acacia Arabica* and *Prosopis spicigera,* the greater part of the surface is barren of vegetation, and the driest parts are an absolute desert. In the lower part of the delta, within reach of the tides, a low jungle of mangroves occupies the swampy islets.

The vegetation of Sindh was first made known to science by Griffith, who traversed the upper part of the province on his way to Afghanistan, and has recorded in his private journals and literary notes the most characteristic plants which he observed. It has also been explored by Major Vicary, who has published in the Asiatic Society's Journal a list of its plants. For our very complete knowledge of its flora we are, however, mainly indebted to the late Dr. Stocks*, whose labours in this interesting province throw much light on Indian botany. Dr. Stocks' collections amount to little more than four hundred species, so that the flora is a very poor one. No doubt, as he has himself stated, a careful exploration of the hilly districts would considerably increase this number; but we feel confident that the novelties would be almost if not entirely western forms, and would therefore increase the proportion, already great, which these bear to forms characteristic of Eastern India vegetation.

More than nine-tenths of the Sindh vegetation, on a rough estimate, consists of plants which are indigenous in Africa. At least one-half of these are common Nubian or Egyptian plants, but which, from being indifferent to moisture, are diffused over all parts of India. As examples we may mention *Gynandropsis pentaphylla, Abutilon Indicum, Tribulus terrestris, Tephrosia purpurea, Glinus lotoides, Grangea Maderaspatana,*

* Since the printing of the earlier part of this Introduction, Indian botany has sustained an irreparable loss by the death of Dr. Stocks, from whose labours much was expected, and to whom we had ourselves looked for valuable assistance in the preparation of these notes on the vegetation of Western India. Fortunately for science a very complete series of his collections exists in the Hookerian and Benthamian Herbaria, accompanied by a catalogue very carefully drawn up, and many important notes, of which we have made use above.

Trichodesma Indicum, Lippia nodiflora, Solanum Jacquini, Ærua lanata, Achyranthes aspera. A smaller number, but still considerable, are tropical African, which are also widely diffused over India. Among these are many *Convolvulaceæ,* as *Batatas pentaphylla, Pharbitis Nil, Ipomœa muricata* and *reptans,* and many of the commonest Indian weeds, such as *Peristrophe bicaliculata* and several species of *Corchorus* and *Triumfetta.* A considerable proportion (perhaps one-sixth of the whole) consists of common Egyptian plants, which are too intolerant of moisture to withstand the climate of the more humid parts of India, but which extend along the Arabian and Persian coasts to Sindh, and thence to the Panjab and the drier parts of the Gangetic plain, and some even to the Dekhan and Mysore. Such are *Peganum Harmala, Cocculus Leæba, Capparis aphylla, Fagonia Arabica, Alhagi Maurorum, Acacia Arabica, Prosopis spicigera, Zizyphus Lotus,* and *Calotropis procera,* all of which extend to the drier parts of the peninsula; and *Malcolmia Africana, Corchorus depressus, Cucumis Colocynthis, Berthelotia lanceolata, Heliotropium undulatum, Salvia Ægyptiaca, Lycium Europæum, Cometes Surattensis,* several *Chenopodiaceæ,* and *Crypsis schœnoides,* which are confined to northern India. With these there occur also a few central European plants, though far fewer than in the northern Panjab, as for example *Ranunculus sceleratus, Convolvulus arvensis, Heliotropium Europæum, Rumex obtusifolius, Asphodelus fistulosus,* and *Potamogeton pectinatus* and *natans.*

Sindh also contains a considerable number of species which have not been met with elsewhere in India, but which are Arabian or Nubian plants. Such are *Zygophyllum album* and *simplex, Balsamodendron, Neurada procumbens, Aizoon Canariense, Seddera latifolia, Trichodesma Africanum, Acanthodium hirtum,* and several *Barleriæ.* A few Persian and Mesopotamian plants not yet known further west, such as *Populus Euphratica* and *Gaillonia,* occur also in the list. *Puneeria coagulans,* Stocks, is confined to Sindh, and the neighbouring province of Beluchistan. Eastern species which find their

western limit in Sindh are almost entirely wanting. The following are all that are contained in Dr. Stocks' catalogue, excluding plants manifestly cultivated (such as *Tamarindus*), *Rhus Mysorensis, Zizyphus Jujuba, Hedyotis aspera, Coldenia procumbens, Salvia plebeia* (a New Holland plant), *Clerodendron phlomoides, Aristolochia bracteata,* and *Zeuxine sulcata.* There are, however, a considerable number of species which have not been met with in Egypt or Arabia, but which belong to genera characteristic of those countries, and are very closely related to Egyptian species. Instances of this kind are *Crotalaria Burhia, Dicoma lanuginosa, Leptadenia Jacquemontiana, Oxystelma esculentum, Linaria ramosissima, Streptium asperum, Solanum gracilipes, Chamærops Ritchiana.* If we add to this enumeration the coast flora of *Sonneratia, Rhizophora, Ceriops, Scævola, Ægiceras, Ipomœa Pes-capræ,* and *Avicennia,* a good general idea is given of the nature of the flora of Sindh.

15. Rajwara.

The districts or states which are included under the general name of Rajwara lie to the north of Malwah, and to the south of the river Jumna. The whole of Marwar, including Jodhpur, Bikanir, and Jesalmir, lies in the basin of the Indus to the west of the Arawali range. The remainder of the province, consisting of the states of Mewar, Jaipur, Kotah, and Gwalior, is situated in the basin of the river Chambal, the great southern branch of the Jumna.

The Arawali mountains, as we have seen, form a continuous range, running from north-east to south-west, which traverses the whole of the province. It dips on its western side very abruptly into the plains of Marwar, which are perfectly level, and are continuous with the great sandy desert stretching west to the Indus. To the eastward, these hills give off numerous spurs, which form low ridges, separating the different branches of the Chambal. The crest of the Arawali range appears never to rise much above 3000 feet, and the head valleys are 1000 feet lower. Thus Udepur and Ajmir, both

close to the crest of the range, have an elevation of about 2000 feet, and are surrounded by hills, the highest of which are about 1000 feet higher. Abu, on a spur to the east of the watershed, is said to attain 4500 feet.

Another range of hills, connected with the Arawali to the south of Udepur, passes by Nimach, and runs parallel with and west of the Chambal, as far as its junction with the Banas. The elevation of Nimach is 1476 feet, and as the surrounding hills are very low, they are perhaps not much higher than 2000 feet. The level of the country gradually sinks towards the north-east. The elevation of Agra above the sea is 670 feet, and the junction of the Jumna and Chambal is a few feet lower.

Rajwara is on the whole a barren province, a great part of it being hilly and unimprovable, but the valleys are occasionally rich and very fertile. The climate is drier than that of Malwah, and becomes very arid in the northern parts. On the western slopes of the Arawali hills there is a considerable rain-fall during the south-west monsoon, but the whole country to the eastward is sheltered by that range from the effects of the monsoon, so that the average rain-fall at Agra is only 19 or 20 inches. The plain of Marwar is even more arid, and the desert which stretches towards the Indus is as dry and sterile as the worst parts of Sindh. The mean temperature of Rajwara is higher than might have been anticipated from its elevation and latitude. At Ajmir and Nasirabad it is 76°.

The vegetation of Rajwara is not known in detail, but it probably differs little from that of the Dekhan and upper Gangetic valley. The forest-clad slopes of the Arawali range are so dry for nine months of the year, that only those trees which are tolerant of great dryness can grow there. They may therefore be expected to present a vegetation similar to that of the hills of Gujerat, or the western and drier Himalaya, where the climate is similar. The summit of Abu, like that of Parasnath, produces some epiphytical *Orchideæ* and other humid types, but their number is no doubt incon-

siderable. The flora of the desert of Jesalmir resembles that of the southern Panjab.

16. Panjab.

The Panjab extends from the northern border of Sindh and Marwar, or rather Jesalmir, to the base of the Himalaya, and from the mountains of Afghanistan, which skirt the right bank of the Indus, to the borders of the Gangetic plain. Strictly speaking, the river Satlej, or Gharra, is the south-eastern boundary of the Panjab, but politically the Cis-Satlej states have been attached to it, and for our purposes it is convenient to draw the boundary along the line which separates the waters tributary to the Ganges from those which flow towards the Indus. This line lies to the eastward of the river Gagar, whose channel may be traced by Bhatnir to the Satlej, a little above Bahawalpur, though its waters are generally absorbed by the desert long before they reach that river. It therefore includes Bahawalpur and Bhatiana, as well as the Cis-Satlej states.

The Panjab, as is well known, derives its name from the five great tributaries of the Indus by which it is traversed. These are the Jelam, the Chenab, the Ravi, the Beas, and the Satlej, all of which, uniting to form the Panjnad, join the Indus near the southern extremity of the province. The surface is on the whole level, but the north-western angle is more or less diversified with hills. West of the Indus there is only a narrow strip of level country, and here and there the hills approach close to the river. No definite physical boundary can therefore be laid down along this frontier, and the political boundary must be adopted. Practically this is of no importance, as the vegetation of the lower hills of Afghanistan is the same as that of the western Panjab.

Between the Indus and the Jelam an elevated platform of considerable elevation (at Rawil Pindi 2000 feet) abuts upon the Himalaya, and south of that town rises into a low range of hills usually known as the salt range, the southern escarp-

ment of which crosses the *Doab** from Pind Dadan Khan in a westerly direction. The summits of this range do not rise higher than 3000 feet. East of the Jelam a very low range of hills, only a few hundred feet in height, runs parallel to that river for some distance from the Himalaya. Elsewhere the country is level, and slopes very gently down from the base of the Himalaya towards the sea. Attok, on the Indus, is elevated 1000 feet, and Lahore about 800 feet above the level of the sea. The junction of the Panjnad with the Indus is elevated about 200 feet.

The climate of the Panjab is very dry. Along the base of the Himalaya the periodical rains are well marked, occurring at the same season as elsewhere in northern India, but their quantity diminishes rapidly in advancing westward, and to the west of the Jelam they disappear. The amount of rain-fall also diminishes in receding from the mountains. At Firozpur and Lahore it is in ordinary seasons very small; and at greater distances from the Himalaya the rains may be said to cease entirely. Throughout the province, however, heavy rain usually falls at midwinter, but does not continue for any length of time.

The mean temperature of the Panjab does not differ materially from that of Agra and Delhi, but is rather lower. The absence of rain in the western and southern parts of the province raises the summer temperature very high, but the coolness of the winter months compensates for this, and reduces the mean temperature of the whole year.

The surface of the Panjab, like that of Sindh, is very fertile where water is procurable for irrigation, but elsewhere it is quite barren. Along the base of the Himalaya, from Ambala as far as the Jelam, there is a very rich belt of fertile country. At a little distance from the mountains, however, the centre of each Doab is dry and barren, and the cultivation is confined to a narrow belt along the great rivers. The soil

* Any tract of country included between two rivers which join is called in India a Doab.

is usually a hard clay, and water is only procurable at great depths. East of the Satlej a sandy desert extends from Sirsa as far as Marwar and the Run of Kach. The streams which descend from the Himalaya and the western face of the Arawali hills are all dissipated before they can mingle their waters with the Satlej, and below Bahawalpur the desert advances close to the river.

The vegetation of the Panjab varies with the climate. In the southern part of the province, where little or no rain falls, the flora is almost identical with that of Sindh; but as the latitude increases and the mean temperature, and especially the winter temperature, diminishes, we find a gradual increase of plants characteristic of the Mediterranean flora, which is fully represented on the mountains of Afghanistan. These are, however, chiefly winter-flowering annuals, such as *Goldbachia lævigata, Frankenia pulverulenta, Silene conica, Arenaria serpyllifolia, Euphorbia Helioscopia, Carthamus oxyacantha, Veronica agrestis, Poa annua,* and their number is not considerable. All the shrubby plants which give the character to the vegetation are the same as those of Sindh. The extensive tracts of low and scattered tree-jungle which occupy the dry clay soil at a little distance from the river, even further to the north and east than Lahore and Firozpur, consist chiefly of *Capparis aphylla, Acacia Arabica* and *leucophlœa, Prosopis spicigera, Zizyphus Lotus,* and *Salvadora oleoides* (*S. Indica,* Royle). *Cocculus Leæba,* a Senegal, Egyptian, and Sindh species, climbs over the trees. *Populus Euphratica* forms thickets along the Satlej, as far east as Bahawalpur, along with *Tamarix Gallica,* which, however, is generally diffused over India. *Berthelotia lanceolata,* a low shrubby plant, which is widely diffused over the drier parts of Asia and Africa, covers large tracts, either quite alone or interspersed with other plants.

Nearer to the Himalaya, as the climate becomes moister, the vegetation changes, the plants of the desert giving place to those of the Gangetic plain. At Ludiana and Jalandhar the shrubby vegetation is quite changed. *Butea frondosa*

has become common, accompanied by all the characteristic forms, which will be enumerated in the next section, and the dry country shrubs have quite disappeared. With the annual herbaceous vegetation the change is less marked, these districts presenting a mixed flora, the cold and hot seasons producing plants of a dry climate, while during the rains more humid types are numerous.

West of the Jelam, wherever the surface is hilly, as is usually the case, it supports a very different vegetation. *Acacia modesta*, and some other species, with a spinous *Celastrus*, form the greater part of the jungle. *Olea undulata*, *Rhazya stricta*, *Dodonæa*, *Reptonia* (*Edgeworthia* of Falconer), and other plants of the lower hills of Afghanistan, occur occasionally, and many mountain plants of the Persian flora, which descend from the hills, are here met with. Several species of *Delphinium*, described in the present part of our work, and numerous *Caryophylleæ*, *Geraniaceæ*, *Cichoraceæ*, *Cynaraceæ*, *Labiatæ*, *Boragineæ*, and other genera of the Oriental flora, might be enumerated as instances; but the flora of this district is still very imperfectly known, no extensive collection of its plants having reached this country. Those which we have seen were collected by Jacquemont, who explored the Salt range; by Dr. Fleming, who has more recently visited the same district, and has communicated to us a complete series of the plants which he collected; and by Major Vicary, chiefly from the neighbourhood of Peshawer.

Griffith's private journals, Jacquemont's 'Voyage aux Indes Orientales,' and Royle's 'Illustrations,' contain many interesting notes regarding the Panjab flora. Mr. Edgeworth has fully investigated the neighbourhood of Multan, and has communicated many specimens to the Hookerian Herbarium. These and our own materials give us a very complete knowledge of its vegetation.

17. Upper Gangetic Plain.

Between the Himalaya on the north and the spurs of the

Vindhia on the south, the Ganges and its tributaries flow through a broad plain, uninterrupted by any inequality of surface. The Jumna above and the Ganges below the junction of the two rivers, flow near the southern margin of the plain, occasionally washing the rocky extremities of the hills, which advance from the southward, and always at no great distance from them, so that the greater part of the plain lies to the north, between these rivers and the Himalaya. As far as the commencement of the delta of the Ganges, its surface is characterized by great uniformity of physical character; it may therefore conveniently be regarded as one botanical province, including the districts of Delhi and Agra on the left bank of the Jumna, which adjoin the Rajput states, the Doab between the Jumna and Ganges, and Rohilkhand, Oude, and Benares, with the district of Tirhut, on the left bank of the Ganges.

Though the Gangetic plain is not separated from the Panjab by any perceptible ridge, the line of separation between the two, which lies very little to the left of the Jumna, between Karnál or Jagadri, and Thanesir, is the most elevated part of the plain which lies at the base of the Himalaya. Ambala, on a branch of the Gogra, and Saharanpur, on the left bank of the Jumna, are each about 1000 feet above the level of the sea, and the high lands on the right bank of the Jumna are probably not more than fifty feet higher. Thence the plain slopes very gradually to the sea, with an average fall of about a foot a mile. Agra is 670 feet, Cawnpore 500 feet, Allahabad 305 feet, and Benares 265 feet above the level of the sea.

The mean temperature of the upper Gangetic plain varies from 78° at its lower extremity, to 72½° at Saharanpur, the diminution being mainly caused by the increased cold of the winter months, as the heat of summer is in all parts very great. The rains set in everywhere soon after the sun has attained its most northern limit. The rain-fall is greatest near the Himalaya, and diminishes gradually as we recede

from the mountains. Along the base of the Himalaya it is greatest to the eastward, and becomes much less in the extreme west. Close to the mountains the amount of fall is not known, but at Benares it is 54 inches, at Gorakpur it is 50 inches, at Moradabad 41 inches, and at Saharunpur only 30 inches. Further from the hills the fall at Meerut is 30 inches, at Alighar 24 inches, at Fattighar 22 inches, at Panipat 25½ inches, at Delhi 21½ inches, at Agra 19½ inches, at Cawnpore 23 inches, at Allahabad 33 inches, and at Mirzapur 35 inches. These numbers present many irregularities, and are probably not to be relied on, but they suffice to show the diminution of rain as the distance from the Himalaya increases. Nor is the reduced rain-fall an accurate indication of the change of climate, as the atmosphere near the mountains is shown by the dew-point observations to be much more moist at all seasons than at a distance.

The flora of the Gangetic plain varies with the degree of humidity. The surface (except along the base of the mountains) is nowhere clothed with forest, but uncultivated tracts are usually covered with a loose bush-jungle, in which *Butea frondosa, Flacourtia sepiaria, Capparis sepiaria, Zizyphus Jujuba* and *Œnoplia, Adhatoda Vasica,* and *Carissa edulis* are among the commonest shrubs, till the climate becomes too dry for them, when they are gradually replaced by the vegetation of the Panjab region, which usually advances as far as the Jumna, and now and then penetrates a little way into the Doab; indeed several of the species which are most characteristic of the arid flora, as, for instance, *Tecoma undulata* and *Berthelotia lanceolata,* were first collected by General Hardwicke in the neighbourhood of Cawnpore. *Alhagi* is also found in the same district, and *Peganum Harmala* is recorded as a native of Monghir.

If we exclude this dry country flora, which just skirts the southern part of the plain, the vegetation of the Gangetic plain presents few peculiar features; indeed a catalogue of the plants of Rohilkhand contains very few species which are not

common all over India, even to the extreme south of the peninsula, in those provinces which have a similar climate. A very few winter-flowering plants (such as *Ranunculus sceleratus*) are the only exceptions, and these are mostly wanderers from the temperate region of the Himalaya. We have already had occasion to direct attention to the remarkable uniformity of the vegetation over large areas of India, and as our information becomes more precise, the sameness becomes more striking.

A considerable portion of the flora of the peninsula does not extend to the upper Gangetic plain, because of the increased cold of winter, and even within the district several plants which are common in the south-eastern portion do not extend to the north-west. *Trichodesma Zeylanicum* is common about Patna, but not found in Rohilkhand. *Cassytha*, which is common in Bahar, is found at Agra, but not on the north of the Ganges. The Palmyra (*Borassus*) is cultivated as far up the Ganges as Alighar and Shahjehanpur, but is not known at Meerut or Moradabad. The only wild palm in the province is *Phœnix sylvestris*.

Near the base of the Himalaya there is always a belt of forest of considerable width; but as it is identical in vegetation with the tropical belt of the mountains, to which indeed it owes its existence, it will be more convenient to notice it in describing the Himalaya.

The vegetation of the upper Gangetic plain, which was first explored by Hardwicke, Govan, and Wallich, was afterwards illustrated in detail by Dr. Royle, whose long residence at Saharunpur gave him ample opportunity of investigating it. In his 'Illustrations,' the influence of the climate upon the vegetation, and the curious transition from the humid to the dry country flora, are first pointed out. Our own collections are chiefly from Rohilkhand.

18. Bengal.

The lower part of the Gangetic plain, which constitutes the

province of Bengal, differs so strikingly in climate and vegetation from the upper, that it must necessarily be regarded as a separate province. Along the sea-coast Bengal includes the whole of the delta of the Ganges, extending from Balasor to the mouth of the Fenny. It is bounded on the west by the hilly districts of Orissa and Bahar, and on the east by the Assam valley, and the Khasia, Tippera, and Chittagong hills. To the north it extends to the base of the Himalaya, but to the north-west the boundary between Bengal and the upper Gangetic plain must be an arbitrary one, the transition of climate and vegetation being gradual; it may, however, conveniently be drawn at the river Cosi. Further west the plains are screened by the Bahar hills from the direct influence of the moist air from the Bay of Bengal, and are therefore drier.

The surface of Bengal is perfectly flat, and so little elevated above the level of the river that a great part of it is under water during the rainy season. Close to the base of the Himalaya the surface is a little more elevated, but elsewhere it is everywhere intersected by watercourses, which are formed by the branching of the two great rivers, the Ganges and Brahmaputra, and of their tributaries.

The climate of Bengal is much more equable than that of the upper Gangetic plain. The rains are heavier and of longer duration; the heat of summer never rises to so excessive a temperature as in the north-west provinces of Hindostan, and the winter is much less cold. North of the Ganges, hot winds blowing from the westward towards the funnel-shaped valley of Assam occasionally traverse the plain, but they are rarely of sufficiently long continuance to affect the vegetation. South of the Ganges the delta is sheltered by the hills of Bahar, so that no hot winds blow, and the atmosphere always remains more or less humid. This humidity is no doubt primarily due to the proximity of the sea, though we learn from the dryness of Sindh, on the opposite side of the peninsula, that that alone is not sufficient to induce it; the main cause would appear to be the proximity of the enor-

mously elevated snow-clad masses of the Himalaya, and the suddenness with which they rise out of the plain.

During the rainy season, when the wind blows from the south, and arrives saturated with moisture at the base of the mountains, a sudden condensation at once takes place; and the distance from the sea is so small, that the effect of the cooling is nearly uniform over the whole area, and does not diminish rapidly as we recede from the mountains, as in the upper provinces. During the remainder of the year, when land winds prevail, the humidity of the atmosphere must be mainly due, as has already been observed (at p. 80), to an upper return current, which is stopped by the high wall of the Himalaya, and, being cooled, sinks towards the earth, and is carried back towards the sea along with the normal current, which descends along the course of the Ganges and Brahmaputra. In support of this explanation, it may be noticed that a belt of equable climate, gradually narrowing as we advance westward, skirts the base of the Himalaya, the summers of the Terai and Himalayan valleys being less hot, and the winters moister and less cold than those of the open plain.

The rain-fall in Bengal varies from sixty to one hundred inches. It is least in the north-western part of the province, and greatest on the eastern sea-coast, near the mouth of the Megna. The mean temperature of Calcutta is 78°, which may be considered as that of the whole area.

The province of Bengal is celebrated for its fertility, and is for the most part under cultivation. The surface is perennially green, and the villages are usually buried among lofty trees; Bamboos, Figs, Mangoes, and various Palms occupying a conspicuous place. The Palms are chiefly Cocoa and Betelnut, *Phœnix*, *Borassus*, and, near the sea, *Corypha*. The two first may be considered the most characteristic cultivated plants, as they are intolerant of cold and do not extend into the drier provinces. Two species of Rattan (*Calamus Roxburghii* and *fascicularis*) are common throughout Bengal, and a third (*C. Mastersianus*), which is common in Silhet and

Assam, is found occasionally in the eastern districts. The indigenous flora is much more extensive than that of the upper Gangetic plain, comprising all the species which grow there except those belonging to the Egyptian or arid flora, besides many others which are not found to the north-west. Ferns are numerous, and a few epiphytical *Orchideæ* are found upon the trees, *Vanda Roxburghii* being the most common. One of the most remarkable forms is a species of rose (*R. involucrata*), which is common in the grassy jungles of the northern parts of Bengal. Many peninsular species which are prevented by the cold of winter from extending northward to the upper Gangetic plain are abundant in Bengal. The common shrubs are species of *Zizyphus, Adhatoda, Calotropis, Carissa, Melastoma, Alangium, Stravadium, Tetranthera, Antidesma,* and *Guatteria suberosa. Pedalium Murex, Tiaridium Indicum, Trichodesma Zeylanicum, Coldenia procumbens, Thespis divaricata,* and *Tiliacora acuminata* may be mentioned as instances of peninsular forms which are equally common in Bengal, but are not found in the upper Gangetic plain. One of the most curious natives of Bengal is *Ethulia divaricata,* a tropical African plant, which is found nowhere else in India. The flora of Bengal does not exhibit much affinity with that of the Malayan Peninsula, containing no *Cycas,* Oaks, nor Nutmegs, though these all grow in Chittagong very little to the eastward, and in the Khasia hills on the north-east frontier.

Within the influence of the tides the delta of the Ganges is covered with a dense jungle of trees peculiar to salt-marshes, called the *Sunderbunds.* This is most largely developed in the western parts of the delta, where the rise and fall of the tides are not considerable, and where there is but little influx of fresh water. To the eastward, near the mouth of the Megna, the bay is almost fresh, and its shores are muddy without vegetation. The rise and fall of the tides are here so considerable, that there is not the same facility for the growth of shrub and trees along the margin of the ocean, that there is

on the banks of the creeks which traverse the Sunderbunds in the western part of the delta. There mangroves, *Sonneratia*, *Ægiceras*, and *Heritiera*, mingled with gigantic grasses and *Typha*, abound. *Nipa fruticans* fringes the watercourses, and vast tracts are covered with *Phœnix paludosa*, an elegant little palm six or eight feet in height.

The vegetation of Bengal has been well explored. The foundation of its flora was laid by Roxburgh, who was appointed in the year 1793 to the superintendence of the Calcutta Botanic Gardens, which, by his labours and those of his distinguished successors Hamilton and Wallich, became very rich in tropical plants. A complete enumeration of the plants of Bengal is found in Roxburgh's 'Flora Indica.' Griffith's 'Itinerary Notes' and Voigt's 'Hortus Suburbanus' also contain notices of many indigenous species.

II. *The Himalaya.*

To the north of the great plain of Hindostan is situated a mountain-tract of great extent, strictly defined on its plainward face, and increasing in elevation as we advance towards the interior. As a whole, this tract is extremely rugged, lofty mountain-chains being separated by deep valleys. Amid the numerous and intricate ramifications of these chains there is considerable difficulty in acquiring a definite idea of the composition of the mass. Superficial observation gives the impression that numerous ranges rise one behind another, the more distant of which are loftier than those in front; but a nearer approach shows the fallacy of this impression, and proves that the arrangement is much less simple.

A prodigiously elevated but scarcely known chain traverses Asia from east to west in about 36° N. lat. South of this chain flow two rivers, the Indus and the Brahmaputra, which, rising nearly together, run in directly opposite directions; one nearly west, the other nearly east. Throughout the greater part of their course they preserve these directions,

but at last both turn abruptly south, to discharge their waters into the Indian Ocean. The chain between these rivers and the plains of India is the Himalaya, which is connected with the still loftier chain of the Kouenlun behind at the common source of these two rivers by mountains of comparatively moderate elevation, which are perhaps portions of a chain running from south-west to north-east, and forming the watershed of Asia as far as the Sea of Japan. Nothing can be more simple than this definition, which is that given by Mr. Hodgson, and we think it is the only one which will suffice. The Himalaya thus includes the whole extent of country between the Indus at Attok and the great bend of the Brahmaputra, but nothing to the west of the Indus or to the east of the Brahmapūtra. The axis of the main chain of the Himalaya lies in general far back, much nearer to the two great rivers which run behind it than to the plains of India; hence the secondary chains on the south face are much more important than those on the north.

The Himalaya may be regarded as consisting of two portions, one on each side of the point of origin of the meridional ridge, by which it is connected with the Kouenlun behind. Of these the Western Himalaya is rather shorter than the Eastern, and it is better known throughout a great part of its course from its lying within British territory, while the Eastern Himalaya is for the most part Tibetan. The elevation of the chain is probably everywhere very great, no known pass across the watershed being of lower elevation than 16,500 feet, except close to the extremities of the chain. The most remarkable depressions in the inner Himalaya are the Rotang Pass between Kulu and Lahul, which is 13,000 feet, and the Zoji Pass between Kashmir and Dras, which is only 11,300 feet.

From the central axis of the chain of the Himalaya a succession of secondary ranges take their origin, which descend on the one hand towards the plains of India, and on the other towards the northern rivers. These secondary chains, on the

Indian side, separate the great rivers which flow towards the plains of India, and which, successively uniting in their courses through the plains, ultimately discharge their waters into the Indus and Brahmaputra, from which they are at first separated by the whole width of the chain of the Himalaya. The great rivers from west to east are in succession—the Jelam, the Chenab, the Ravi, the Beas, the Satlej, the Jumna, the Ganges, the Gogra, the Gandak, the Cosi, the Tista, the Monas, and the Subansiri; all of these are separated by chains at first of great elevation, but which terminate at last abruptly in the plains of India. Some of these chains are now well explored, but others, especially those in Nipal and Bhotan, are still very imperfectly known. They vary a good deal in direction, some being almost perpendicular to the main axis, while others form with it a very acute angle. They all ramify very much, giving off chains of the third order, separating the tributaries of the great rivers.

The length of the chain of the Himalaya, from the Indus to the Brahmaputra, may be estimated at about 1400 miles, while its width varies from 200 to 100 miles. Most of the lofty peaks with which we are acquainted are situated on the secondary chains, but the mean height of the main axis is probably greater. The elevation of the secondary chains diminishes, on the whole, as they approach their termination in the plains, though with a certain degree of irregularity. In length these vary considerably, according to their direction, but we must refer to the map for details of their structure and arrangement. It will be seen that their ramifications are innumerable; their flanks are in general steep, and separate deep valleys. Open plains are rare, but occur occasionally at all elevations, and there are a few inconsiderable lakes. The mean slope of the Himalaya from the plains to the axis is not more than 1 in 25, and the mean slope of the ridges of the scondary chains, which are usually very oblique, and always sinuous, must be considerably less. It is important to keep in view these numbers, which serve to correct the erroneous

estimates usually formed of the steepness of these mountains. The chain does not run due east and west, its western extremity being in 35° north latitude, while the latitude of the east end is only 28° north.

Though the Gangetic and Panjab plains, from which the Himalaya rises abruptly, are for the most part devoid of trees, or covered only with scattered jungle, there is usually a belt of forest ten or twenty miles in width, along the base of the mountains, composed of the same trees which form the mass of the tropical vegetation of the lower hills.

The extension of the forest over the plain is no doubt the effect of the equable and humid climate which prevails along the base of the mountains, but the nature of the drainage is also not without its influence. The forest grows usually on slightly inclined gravelly slopes, and is succeeded on the side furthest from the mountains by a swampy tract, without trees, and covered with long grasses, called the Terai. Beyond the Terai the surface generally rises again slightly, so that the swampy tract may be regarded as a series of flat-floored valleys, skirting the base of the mountains; or rather, in a strictly scientific point of view, it consists simply of the outermost valleys themselves, and the bases of the mountains forming scarcely perceptible undulations between them.

Immediately within the mountains the first series of lateral valleys are often broad and bounded by low hills, or on one side (the southern) by low hills, and on the other (the northern) by considerably higher ones. These are known by the name of *Dhúns* (Doons); and when very open, flat-floored, and with gradually sloping beds, their true relation to the surrounding mountain-chains is not at once apparent. Sometimes they appear to be indefinitely extended east and west, in a direction parallel to the Himalayan chain; and, running from one great river to another, they appear to belong to a different order of valleys from what occur further within the mountains. This arises in some cases from the slope of their beds being so extremely gradual, that the watershed

between the valley that ascends from one river, to the corresponding valley that descends to the other river, can only be detected by the observation of the drainage; whence the two valleys appear to form one. Such is the case with the Dehra Dhún, which appears to form one continuous transverse valley between the Jumna and the Ganges, but which really consists of two valleys; one descending from the village of Dehra (which occupies the *col*) westerly to the Jumna, and the other descending from the same spot easterly to the Ganges. Other Dhúns, again, are simply very broad, open valleys, differing in no physical features from those that occur in other parts of the mountains. In the Panjab-Himalaya, where the tertiary sandstones acquire a great development, two or three such valleys occur in succession before the higher mountains begin. These valleys, or Dhúns, are not, as is very generally supposed, continuous along the whole extent of the Himalaya, and interposed between the tertiary and secondary mountains. They are merely the outer series of lateral valleys, and are always of limited extent.

In the enormous chain of the Himalaya, which rises nearly from the level of the sea to perpetual snow, we have of course every variation of temperature between tropical or subtropical heat and extreme cold. The diminution of temperature is 1° for 300 feet of elevation in the more humid, and for 400 feet in the drier part of the chain. The elevation of the snow-line, at equal distances from the plains, is nearly uniform throughout the whole extent of the chain, the increase of latitude of the more westerly part being compensated for by the greater distance from the sea, and consequent diminished snow-fall. This level on the outer ranges has been determined to be about 16,000 feet, but it becomes higher on the inner ranges, and in the Tibetan Himalaya is not under 19 or 20,000 feet.

The climate of the Himalaya varies much in different parts. During the winter season the weather is generally unsettled; for while the north-east monsoon is blowing over the lower

parts of India, an upper current of south-westerly wind carries its moisture to the higher mountains, where it is condensed in the form of snow. Snow falls in the eastern parts, in severe seasons, as low as 5000 feet, and in the north-west occasionally as low as 2000 feet. The ordinary limit, however, is several thousand feet higher. After the vernal equinox, by which time the south-west monsoon has fairly set in, the sky is usually serene and the weather beautiful. To the eastward this rule is subject to frequent exceptions, the same causes which make the climate of Bengal humid at all seasons operating more markedly on the Himalaya to the northward of that province. As summer advances, the wind becomes more humid, and occasional heavy thunder-storms in the afternoons mark the approach of the rains, which set in about midsummer; considerably earlier, however, in the eastern than in the north-western Himalaya. During the rainy season, which continues almost till the autumnal equinox, when the decreasing declination of the sun changes the direction of the wind, the atmosphere is very humid, usually almost to saturation. There are, however, occasional interruptions in the rains, during which the weather is superb. The rain-fall is greatest to the eastward, and diminishes gradually in advancing westward.

As the source of the deluge of rain which falls on the Himalaya is very distant, a great part of the moisture is necessarily deposited on the first range with which the humid wind comes in contact, of sufficient elevation to cool the air to the point of saturation. The rain-fall is therefore greatest on ranges elevated from 6 to 10,000 feet, especially where these advance in considerable masses near to the plains, while isolated peaks, and ranges of lesser elevation, as well as the valleys of the great rivers, are evidently drier. As a consequence of this, all the valleys of the interior which are separated from the plains by continuous chains, attaining an elevation of 10–12,000 feet, are to a great extent sheltered by these from the rains, which fall only as occasional showers;

while those still further back, and bounded on the plainward face by mountains rising everywhere to the level of perpetual snow, are absolutely without rain during the monsoon. In Sikkim and Bhotan, where the wide valleys are perpendicular to the axis of the chain, and correspond to the direction of the winds, the rains are heavy till we penetrate far into the interior, but great irregularities everywhere occur even in adjacent valleys; thus the transverse chain of the upper Tista makes the climate of the higher parts of the Lachen valley much drier than that of the Lachung river, though the two are only a few miles apart.

We meet, therefore, in the Himalaya, with all the modifications of climate which have already been enumerated as occurring in India, and the aspect of the mountains varies with the climate. In the permanently humid parts the mountains are covered everywhere with an uniform sombre forest, masking all inequalities of surface, and giving a dull and monotonous aspect to the scenery. This forest rises to the upper limit of trees, at 12–13,000 feet, and is succeeded by grassy pastures, which ascend to the snow-line. Forests are also plentiful where the dry season is well marked and the rains abundant; but they are there confined to the shady and moister exposures, while the sunny slopes and all the lower hills are grassy and rocky. The permanently arid mountains of the extreme west are barren and rocky, and devoid of trees at all elevations.

In the temperate valleys of the inner Himalaya, where the rain-fall is moderate in amount and the ground is permanently covered with snow during winter, and where the hot summer's sun powerfully stimulates vegetation, the mountain slopes present a delightful intermixture of beautiful forest and of luxuriant vegetation; while above the limit of trees the compact turf is enamelled with myriads of lovely flowers, nourished by the melting snows and the genial warmth of summer. To this, however, as we penetrate further into the interior, a barren, treeless climate rapidly succeeds, in which the princi-

pal vegetation occurs at the commencement of spring, when the melting snow supplies abundant moisture to small annual plants, which run their course with great rapidity, and are speedily shrivelled up by a scorching sun.

As respects climate, we have therefore two different systems of division of the Himalaya:—1, into the tropical, temperate, and alpine zones; and 2, into the exterior or rainy, the interior or intermediate, and the Tibetan or arid Himalaya.

The term tropical is not strictly applicable to any part of the chain, which is nowhere within the tropics, but we find it convenient to adopt it, and, the vegetation being strictly tropical, it can, we think, lead to no inconvenience; while the only word which could be substituted, namely *subtropical,* is required to express the transition from the vegetation of the base to that of the temperate zone. There are of course no strict lines of demarcation between the three zones first enumerated; but they are sufficient to express the three prominent changes in the vegetation which correspond to those observable in passing from the equator towards the poles, and on the whole are sufficiently distinct to be readily recognizable.

In the extreme west the tropical belt rises to about 4000 feet, and as we advance eastward its elevation gradually increases. In Kumaon it is 5000 feet, and in Nipal rather higher. In the permanently humid country to the eastward it rises still higher, tropical vegetation being found as high as 7000 feet; but the equable nature of the climate masks the effect, and carries many temperate plants much lower than that level. The alpine zone may be said to commence at the upper limit of trees, which varies from 12,000 feet in the extreme west to nearly 13,000 feet in the eastern Himalaya. A number of trees and shrubs which are peculiar to the higher part of the temperate zone, we shall generally characterize as subalpine.

The division of the Himalaya into exterior, interior, and Tibetan, corresponds in the temperate zone to very marked

differences of vegetation. In the great valleys the tropical flora stretches far into the interior, and is much the same there as in the outer portion of the mountains. In the exterior Himalaya there is a well marked rainy season. The width of the belt of the exterior or humid Himalaya is much greater to the eastward than in the extreme west, the rain-fall and humidity being much less to the westward. We therefore find the plants of the interior zone advancing much nearer to the plains in the western Himalaya than they do in the eastern, where a humid or rainy climate vegetation penetrates far into the interior. In the outer zone of the eastern Himalaya, indeed, a vegetation characteristic of an equable climate prevails throughout the year, while to the westward those families which delight in humidity only make their appearance with the commencement of the rainy season, before which time no *Zingiberaceæ*, terrestrial orchids, especially *Malaxideæ*, *Cyrtandraceæ*, *Acanthaceæ*, or balsams, are to be met with.

Considered with respect to its longitudinal extent, the Himalaya, when regarded solely from a physical point of view, consists of only two divisions, a western and an eastern, corresponding respectively to the Indus and Brahmaputra. For botanical purposes, however, the chain requires to be divided into western, central, and eastern Himalaya. The kingdom of Nipal, in the middle, constitutes the whole of the central Himalaya. To the eastward lie Sikkim, Bhotan, and Abor, to the westward Kumaon and the Panjab Himalaya.

We have thus three principal series of divisions of the Himalaya, according to length, breadth, and height. Accordingly we say—

1 (*longitudinally*). The eastern, central, and western Himalaya.

2 (*latitudinally*). The exterior, interior, and Tibetan Himalaya.

3 (*altitudinally*). The tropical, temperate, and alpine Himalaya.

A combination of these three modes of division will be our usual mode of defining the localities of the plants. In the great majority of cases these terms are abundantly sufficient for our purposes, the range of each species being very considerable. There are, however, many instances in which it is desirable to enter into further detail, and in such cases we shall either make use of the river valleys (a very convenient mode of indicating the regions), or of the political subdivisions usually recognized. To these we shall refer in the following remarks on the great geographical divisions, which correspond to the longitudinal divisions given above, with the addition of a fourth, namely, Tibet, which includes not only the Tibetan slope of the Himalaya,—that is to say, the ramifications which extend from its axis towards the Tibetan Brahmaputra and Indus,—but also the mountainous country to the north of these rivers, as far as the axis of the chain of the Kouenlun.

Eastern Himalaya.

In this are included the states of Sikkim and Bhotan, and the districts lying to the eastward of the latter as far as the great bend of the Brahmaputra, which we shall call collectively by the name of Abor.

1. Abor.

To the eastward of the Subansiri river there is probably only one range of any considerable elevation, and the mountains by which the Himalaya terminates in that direction perhaps nowhere attain a greater height than eight or ten thousand feet, while the valley of the Dihong or Brahmaputra is probably broad and open. These mountains are inhabited by wild and suspicious tribes, who have hitherto refused all access to the interior of their country. The climate and vegetation are probably identical with those of the Mishmi mountains, to the eastward of the Brahmaputra, which will be noticed in a future page.

2. Bhotan.

Bhotan is at present one of the least accessible parts of the Himalaya, and is only known to us by the narratives of Turner and of Pemberton; for Mr. Bogle, who passed through it in 1774, has left no record of his journey. Captain Turner traversed the most westerly part of the province, from the plains of Bengal to the towns of Tashisudon and Panaka, and, after a short residence in Tibet, returned by the same route to India; he has not, in his 'Travels,' given any details of the vegetation.

Major Pemberton, who was accompanied by Mr. Griffith, entered Bhotan a little to the west of the meridian of Gowahatti, in Assam, and crossed a range of mountains into the valley of the Monas river, whence he travelled in a westerly direction across high mountains to the valley of the Pa-chu. This river, which rises to the eastward of Chumalari, in Tibet, has an almost due south course to the plains; but the Monas as well as the Subansiri have a south-west course in Bhotan: higher up they probably run south-east, and bend round to south-west in a curve somewhat parallel to that of the Yaru or Dihong, which afterwards becomes the Brahmaputra.

In western Bhotan the mountain-ranges are lofty and rugged, and the river-courses very deep and generally narrow. At Panaka the Pa-chu is only 3700 feet above the sea, though eighty miles distant from the plains; and the Monas, where Pemberton and Griffith crossed it, is only 1400 feet, while the range south of it attains an elevation of 9500 feet. In their journey from the Monas to Panaka, these travellers crossed ridges 12,400 feet in height. On their return to India they followed Captain Turner's route.

The mountain mass which descends from the axis of the Himalaya to separate the Monas from the Subansiri attains an elevation of at least 24,000 feet as far south as latitude 28°. Three peaks upon this are visible from the Khasia mountains, and spurs descending from it were ascended to an elevation

of nearly 12,000 feet by Mr. Booth in 1849, in a district north of Bishnath, in Upper Assam, which is inhabited by a race called Duphlas. He collected some Ferns, and especially seeds of Rhododendrons, of which an account has been published by Nuttall in 'Hooker's Journal of Botany.'

Mr. Griffith's attention was of course mainly devoted to the botany of the district, and in his 'Itinerary Notes' and journals we have a mass of important information regarding the general features of the vegetation, together with a great deal of detail which will become valuable as soon as the species are determined.

The climate of Bhotan seems to be very equable, and the humidity of the winter months appears to increase to the eastward. We do not, however, possess any records of temperature or humidity, and our inferences regarding the climate are drawn from the vegetation only. The steepness with which the mountains rise, and the influence of the elevated mass of the Khasia to the south, make the lower mountains which skirt the plains of Assam, between the Godada and the Monas, drier than those nearer Sikkim, which are exposed to the full force of the monsoon, or than those further east.

The deep narrow valleys of the great rivers carry a tropical vegetation very far into the interior of Bhotan, among lofty mountains capped with almost perpetual snow. These attract to themselves so much of the moisture of the atmosphere, that the bottoms of the valleys are everywhere comparatively dry and bare of forest, which only begins at about 6000 feet of elevation, except in ravines. The outer ranges, too (except near Sikkim), even above this level are only partially wooded, the trees being arranged in clumps, among which are interspersed open grassy glades, which are compared by Griffith to those of Khasia; Oaks and Rhododendrons being extremely abundant.

On the northern face of the range which separates the Monas valley from Assam, Pines make their appearance, the first species being *Pinus longifolia* in the drier valleys below 6000

feet. On the more humid ranges *Abies Brunoniana* appears at 8000 feet, and above it *Picea Webbiana*. *Pinus excelsa* also occurs abundantly, as well as the Yew, and *Cupressus funebris* is cultivated as low as 2000 feet, and a very little way from the Assam plain. Further in the interior *Abies Smithiana* occurs, and *Larix Griffithii* to the westward, *Pinus longifolia* being still found in the hot dry valleys.

In general features the flora of Bhotan resembles that of Sikkim, which is much better known. It differs principally by containing several Khasia and eastern forms which do not extend further west, such as *Liquidambar, Corylopsis,* and an oak with leaves like *Robur* (*Quercus Griffithii,* H.f. et T.). These are chiefly plants of the subtropical and lower temperate zone; while those of the upper temperate and subalpine zone appear, so far as we have had an opportunity of comparing them, to be almost identical with those of Sikkim. It must, however, be recollected that the collections of Griffith are all from the western parts of Bhotan, and that the eastern parts are not at all known.

3. Sikkim.

The province of Sikkim, though of very limited extent, is now the best known part of the central or eastern Himalaya, and presents many features of much interest. It consists entirely of the basin of the river Tista, which, with its tributaries, drain the whole country. The course of this river is for the most part meridional, that is, perpendicular to the plains; and the same may be said of its great tributary the Rangit river, which joins it from the west, flowing for a short distance parallel to the plains, through a deep ravine not 1000 feet above the sea, to the north of a transverse range elevated 7–8000 feet.

The position of Sikkim, opposite to the opening of the Gangetic valley, between the mountains of Bahar on the one hand, and those of Khasia on the other, exposes it to the full force of the monsoon; its rains are therefore heavy and almost

uninterrupted, and are accompanied by dense fogs and a saturated atmosphere. This weather indeed prevails throughout the year, as there are frequent winter rains, which are generally accompanied by cold fogs, and alternate with frost and snow. March and April are the driest months, and in fine seasons are often bright and clear, but the rains commence in May, to continue with little intermission till October. The bounding mountain-chains are very lofty, and snow-clad throughout a great part of their extent, but the central range which separates the Rangit from the Tista is depressed till very far in the interior. The river-valleys are also considerably depressed, but less markedly so than those of western Bhotan. The rainy winds have thus free access to the heart of the province, and sweep almost without interruption up to the base of Kanchinjanga (28,178 feet), the loftiest mountain and most enormous mass of snow in the world. The snow-level is here about 16,000 feet. Between the two principal sources of the Tista, however, the Lachen and the Lachung, a lofty snowy range is projected; and as this chain has a south-west direction, and is moreover sheltered to a considerable extent by the boundary chain between Sikkim and the Tibetan valley of Chumbi, we have in these valleys a rapid diminution of the rain-fall and an equally rapid transition to the Tibetan climate, while the level of perpetual snow rises to above 18,000 feet.

From the level of the sea to an elevation of 12,000 feet Sikkim is covered with a dense forest, only interrupted where village clearances have bared the slopes for the purposes of cultivation; and there the encroachment of the forest is with difficulty prevented by frequent fires and the incessant labour of the villagers. The forest consists everywhere of tall umbrageous trees; with little underwood on the drier slopes, but often dense grass jungle; more commonly however it is accompanied by a luxuriant undergrowth of shrubs, which renders it almost impenetrable. In the tropical zone large Figs abound, with *Terminalia, Vatica, Myrtaceæ*, Laurels, *Eu-*

phorbiaceæ, *Meliaceæ*, *Bauhinia*, *Bombax*, *Morus*, *Artocarpus*, and other *Urticaceæ*, and many *Leguminosæ*; and the undergrowth consists of *Acanthaceæ*, Bamboos, several *Calami*, two dwarf *Arecæ*, *Wallichia*, and *Caryota urens*. Plantains and tree-ferns, as well as *Pandanus*, are common; and, as in all moist tropical countries, ferns, orchids, *Scitamineæ*, and *Pothos* are extremely abundant. Few oaks are found at the base of the mountains, and the only conifers are a species of *Podocarpus* and *Pinus longifolia*, which frequents the drier slopes of hot valleys as low as 1000 feet above the level of the sea, and entirely avoids the temperate zone. The other tropical Gymnosperms are *Cycas pectinata* and *Gnetum scandens*, genera which find their north-western limits in Sikkim.

The rarity of oaks at the base of the mountains must be ascribed to the great dryness and winter's cold of that part of the chain, for we miss also other eastern types which abound in the equable and moist climate of the Malayan archipelago and peninsula, such as *Liquidambar* and nutmegs; whilst *Dipterocarpeæ*, and especially *Anonaceæ*, are exceedingly few in number. *Liquidambar* is common in the Assam jungles, and indicates their greater humidity. The same inference may be drawn with regard to the tropical belt of the Khasia, from the occurrence there of two nutmegs and numerous *Anonaceæ*.

Oaks, of which (including chesnuts) there are upwards of eleven species in Sikkim, become abundant at about 4000 feet, and at 5000 feet the temperate zone commences, the vegetation varying with the degree of humidity. On the outermost ranges, and on northern exposures, there is a dripping forest of cherry, laurels, oaks and chesnuts, *Magnolia*, *Andromeda*, *Styrax*, *Pyrus*, maple and birch, with an undergrowth of *Araliaceæ*, *Hollböllia*, *Limonia*, *Daphne*, *Ardisia*, *Myrsine*, *Symplocos*, *Rubi*, and a prodigious variety of ferns.

Plectocomia and *Musa* ascend to 7000 feet. On drier exposures bamboo and tall grasses form the underwood. Rhododendrons appear below 6000 feet, at which elevation snow falls occasionally. From 6–12,000 feet there is no apparent

diminution of the humidity, the air being near saturation during a great part of the year; but the decrease of temperature effects a marked change in the vegetation. Between 6000 and 8000 feet epiphytical orchids are extremely abundant, and they do not entirely disappear till a height of 10,000 feet has been attained. Rhododendrons become abundant at 8000 feet, and from 10,000 to 14,000 feet they form in many places the mass of the shrubby vegetation. *Vaccinia,* of which there are ten species, almost all epiphytical, do not ascend so high, and are most abundant at elevations of from 5000 to 8000 feet.

The flora of the temperate zone presents a remarkable resemblance to that of Japan, in the mountains of which island we have a very similar climate, both being cold and damp. *Helwingia, Aucuba, Stachyurus,* and *Enkianthus* may be cited as conspicuous instances of this similarity, which is the more interesting because Japan is the nearest cold damp climate to Sikkim with whose vegetation we are acquainted. At 10,000 feet (on the summit of Tonglo) yew makes its appearance, but no other conifer except those of the tropical belt is found nearer the plains than the mountain Phalút, north of Tonglo, on which *Picea Webbiana* is found, at levels above 10,000 feet. *Abies Brunoniana* is first met with at 9000 feet in the Rangit valley, at Mon Lepcha, and *A. Smithiana* and *Brunoniana,* and the larch, are found everywhere in the valleys of the Lachen and Lachung rivers, above 8000 feet. The Pines are thus specifically the same as those of Bhotan, except *Pinus excelsa,* which occurs nowhere in Sikkim.

A subtropical vegetation penetrates far into the interior of the country along the banks of the great rivers; rattans, tree-ferns, plantains, screw-pines, and other tropical plants occurring in the Ratong valley, almost at the foot of Kanchinjanga, and 5000 feet above the level of the sea. With the pines, however, in the temperate zone, a very different kind of vegetation presents itself. Here those great European families which are almost entirely wanting in the outer

temperate zone become common, and the flóra approximates in character to that of Europe, though not to the same extent as that of the western Himalaya does. Shrubby *Leguminosæ,* such as *Indigofera* and *Desmodium, Ranunculaceæ* (*Thalictrum, Anemone, Delphinium, Aconitum,* etc.), *Umbelliferæ, Caryophylleæ, Labiatæ,* and *Gramineæ,* increase in numbers as we advance into the interior. The air becomes drier, and from the increased action of the sun the temperature does not diminish in proportion to the elevation, the summers being warmer, though the winters are colder. The forests at the same time become more open, and are spread less uniformly over the surface, the drier slopes being bare of trees, and covered with a luxuriant herbaceous vegetation. It is only in the upper part of the valley of the Tista, however, above the junction of the Lachen with the Lachung, that this change becomes marked; and from the rapidly increasing elevation, not only of the surrounding mountains, but of the floors of the valleys, it proceeds with great rapidity, and the temperate soon gives place to an alpine flora.

The subalpine zone in Sikkim scarcely begins below 13,000 feet, at which elevation a dense rhododendron scrub occupies the slopes of the mountains, filling up the valleys so as to render them impenetrable. Here the summer is short, the ground not being free of snow till the middle of June. It is, however, comparatively dry, and the alpine flora very much resembles that of the western Himalaya and (in generic types at least) the alps of Europe and western Asia; while as we advance towards the Tibetan region we have a great increase of dryness, so that a Siberian flora is rapidly developed, which at last entirely supersedes that of the subalpine zone, and ascends above 18,000 feet.

A small herbarium of Dorjiling plants was, we believe, formed by collectors sent by Griffith while in charge of the Calcutta Botanic Garden, but our knowledge of the vegetation of Sikkim is entirely derived from our own collections, which we believe to be very complete. These consist of about

2770 species of flowering plants and 150 ferns, of which the majority inhabit the temperate zone; fewer are tropical, and still fewer alpine. The prevailing natural orders are:—

Ranunculaceæ	55	Gentianeæ	38
Papaveraceæ	25	Asclepiadeæ, Apocyneæ	45
Fumariaceæ	16	Scrophularineæ	70
Magnoliaceæ	7	Labiatæ	90
Malvaceæ, Bombaceæ, Tiliaceæ, Byttneriaceæ	30	Cyrtandreæ	27
		Myrsineæ	12
		Primulaceæ	36
Ternstrœmiaceæ	11	Boragineæ	18
Aurantiaceæ	12	Acanthaceæ	35
Caryophylleæ	30	Polygoneæ	45
Cruciferæ	30	Euphorbiaceæ	35
Vitaceæ	20	Urticeæ	110
Balsamineæ	18	Amentaceæ	15
Acerineæ	6	Coniferæ	10
Leguminosæ	100	Laurineæ	30
Rosaceæ	80	Aroideæ	16
Umbelliferæ	50	Orchideæ	150
Araliaceæ	26	Scitamineæ	24
Melastomaceæ	10	Palmeæ	10
Cucurbitaceæ	20	Smilaceæ, Liliaceæ	40
Rubiaceæ	80		
Crassulaceæ	16	Junceæ	25
Compositæ	170	Gramineæ	180
Ericeæ, Vaccinieæ	60	Cyperaceæ	106

Central Himalaya, or Nipal.

The kingdom of Nipal extends for 500 miles along the Himalaya, from the western extremity of Sikkim to the eastern border of Kumaon, from which it is separated by the river Kali. The jealous policy of the Nipalese government has prevented our acquiring an intimate knowledge of this country, the only part to which Europeans have been allowed access

(with one exception) being the capital, Kathmandu, elevated 4000 feet above the sea, and distant about thirty miles from the plains of India. Here a British Resident has resided since 1817, and several botanists have been enabled to explore its vegetation. To these the Government of Nipal, though invariably refusing permission to penetrate far into the interior, has always afforded every facility for prosecuting their researches by permitting the despatch of collectors.

Dr. Buchanan Hamilton visited Nipal in 1802, remaining for more than a year, during which time he explored the valley of Kathmandu and surrounding mountains. His plants were described by David Don in the 'Prodromus Floræ Nepalensis,' a work which should have been alluded to in conjunction with Wallich's 'Tentamen' at page 51. In 1820 Dr. Wallich arrived at Kathmandu. During his residence in the valley he laboured indefatigably in the investigation of the rich and scarcely known flora by which he was surrounded; collectors were despatched in every direction, and a great Herbarium was formed, which is well known to science. The flora of the subtropical and lower temperate zone was probably almost wholly exhausted; but the alpine zone was much less completely explored, as the task had to be confided to Bengali collectors, who dread cold, and by whom many small alpine plants would naturally be overlooked. The collectors were sent to the valley of the Gandak and the neighbourhood of the great mountain Gosainthan.

In 1845, Dr. Hoffmeister, a German traveller and botanist, visited Kathmandu, but we have not had an opportunity of learning whether or not he made any collection there. A small collection, which now forms a part of the Hookerian Herbarium, was made there by the late Mr. Winterbottom. Between the Gandak and the Kali the country has not been traversed by any European, nor had any part of eastern Nipal been visited till 1848, when Dr. Hooker, by permission of the Nipalese Government, entered it from Sikkim, visited the Tambar river, the most easterly tributary of the Aran, ascend-

ing its valley from an elevation of 1000 feet, as far as its sources in the Walanchún and Kanglachem passes (16–17,000 feet). This journey was made during winter, and therefore gave less important results botanically than would have been obtained at a more favourable season.

It is unnecessary to dwell at length on the general character of the surface of Nipal, as to do so would only be to recapitulate what has already been said regarding the Himalaya in general. Little is known of the details of the higher parts of the chain, or of the position of the axis of the Himalaya, which probably lies in general very far back. The political frontier of Tibet is usually far to the south of the axis, the upper part of the course of most of the rivers of the Indian slope of the chain belonging almost invariably to Tibet. Two giant masses project from the axis towards the Indian plain, the culminant peaks of which form a conspicuous feature from Kathmandu, and even from the Gangetic plain, so that their elevation has been approximately determined; that of Dhawalagiri being 27,600 feet, and that of Gosainthan 24,700 feet. By these masses the whole of Nipal is divided into three great river-basins,—that of the Karnali or Gogra to the westward, that of the Gandak in the centre, and that of the Kosi or Aran to the eastward*. These divisions are no doubt highly natural. For our purposes a subdivision is little necessary, from our very slight acquaintance with the flora of any part of Nipal except that in which Dr. Wallich collected, and it will suffice to distinguish eastern, central, and western Nipal, whenever it appears requisite to assign particular localities to our plants.

* See an excellent paper by Mr. Hodgson in the Journal of the Asiatic Society of Bengal, in which the importance of the river-basins as geographical divisions is forcibly pointed out. Mr. Hodgson has however misunderstood Captain Herbert's views, which are certainly the same as his own in that respect. Captain Herbert's proposition, that the line of the great peaks intersects the river-basins (and is therefore not the true axis of the Himalaya), was the first enunciation of a very important fact in physical geography, the true significance of which is not yet duly appreciated.

There are probably many mountains equally elevated with those just enumerated, but bearing a less important relation to the river systems. A very lofty peak between the Kosi and its tributary the Aran has been conjectured to be almost as lofty as Kanchinjanga, but on very imperfect data. The uniform appearance of snowy masses throughout the whole extent of Nipal, leaves no doubt, however, as to the great elevation of the axis of the chain and the mountains of the interior.

With regard to the outer mountains we have no detailed information, except of those in the immediate neighbourhood of Kathmandu, where Sheopore, on the watershed between the Gandak and the Kosi, is upwards of 10,000 feet. On the whole, if we may judge from the distribution of the rivers, the outer mountains of Nipal are probably less elevated than those of other parts of the Himalaya, the width of the river basins being comparatively great, so that the boundary ridges ramify repeatedly, and run for a considerable length without much increase of altitude. In eastern Nipal the outer and central ranges are very much lower than those of Sikkim, and the open valleys and low mountains of central Nipal indicate that the same is the case there.

The climate of Nipal has been discussed with that of the Himalaya generally. There is probably a somewhat abrupt transition from the humid winter of Sikkim to the drought which prevails at that season in the western Himalaya, as the proximity, not only to the sea, but also to the great mass of snow-clad mountains which in Sikkim advances to within sixty miles of the plains, is no doubt the cause of the superabundance of moisture in that province. We may therefore expect to find all the eastern or humid types of the subtropical Sikkim flora wanting in the forest between Kathmandu and the Gangetic plain. Accordingly, among palms, *Areca gracilis* and *disticha, Licuala* and *Caryota* have disappeared, and one or two *Calami, Chamærops, Phœnix acaulis,* and *Wallichia* alone occur. With diminished humidity we find increased

sun-power, to which the open nature of many of the valleys contributes in no small degree.

The principal plants of the tropical zone of Nipal belong to a less humid type than those of Sikkim, and are abundant all over the subtropical mountains of India, where a dry and wet season alternate. The commonest trees are *Moringa, Putranjiva, Bombax, Vatica robusta, Buchanania, Spondias, Butea frondosa* and *parviflora, Erythrina, Acacia Lebbek* and *stipularis, Bauhinia purpurea* and *Vahlii, Ventilago, Conocarpus, Terminalia, Nauclea cordifolia,* and *Ulmus integrifolia.*

In the plain of Kathmandu, which is elevated 4000 feet, the ground is in a great measure under cultivation, and the hills are bare of trees. The vegetation and climate are therefore subtropical, and from the position of the Kathmandu plain, close to the ridge of the spur which separates the basins of the Gandak and Kosi, its mean level is probably greater than that of many of the valleys of both rivers, and of the ridges which separate their tributaries.

In the temperate flora of central Nipal, for the same reason, the Japanese and Malayan types are much fewer; *Enkianthus, Stachyurus, Vaccinia, Aucuba, Helwingia,* several *Rubi,* and *Rhododendron Dalhousiæ* and *Edgeworthii* being all absent, while European and west Himalayan forms which are wanting in Sikkim make their appearance. In the extreme east of Nipal, in the valley of the Tambar river, Rhododendrons are scarcely less abundant than in Sikkim; but those of the temperate zone are certainly entirely wanting in that part of central Nipal from which Dr. Wallich obtained his collections, with the exception of *R. arboreum,* which is found throughout the whole Himalaya, *R. barbatum,* which extends to Kumaon, and *R. campanulatum,* which is a subalpine species. The more alpine species cannot be so positively affirmed to be absent, but it is highly probable that the number of species is not great, none having been obtained by Dr. Wallich's collectors, but such as are universally distributed throughout the Himalaya. The pines are the same as those

of Sikkim, except that *Pinus excelsa* is common, and the larch is not found west of the Kosi.

In the present state of our knowledge, it is not safe to institute a comparison between the alpine flora of Nipal and that of Sikkim. Wallich's collections show us that the species are on the whole the same. There is evidently a very gradual change as we advance westward, partly owing, it may be presumed, to increase of latitude and of summer drought, and partly to more obscure causes which regulate the distribution of plants. The elucidation of these will, we trust, be one of the most important results of this work when completed, but with our present imperfect knowledge of species the subject cannot be approached. The occurrence of Siberian types in small numbers among Wallich's alpine plants shows that the climate to the North becomes at last arid, exactly as elsewhere in the Himalaya.

Though unable to indicate with any approach to precision the number of Nipalese genera and species that are common to the Eastern and Western Himalaya respectively, we have collected a few instances of Himalayan species that we believe find their limits in Nipal. Of these the majority of the Western Himalayan forms that advance no further east are of European and Oriental genera or even species, as:—

Caltha *palustris*.
Delphinium *vestitum*.
Cratægus *Pyracantha*.
Rosa *moschata*.
Ulmus *campestris*.

Others are more peculiarly Himalayan:—

Chamærops *Martiana*.
Quercus *lanata*.
Stranvæsia *glaucescens*.
Rosa *Lyellii*.
Potentilla *atro-sanguinea*.
„ *Nipalensis*.
Spiræa *Kamtschatica*.

Of these the *Stranvæsia*, though not found further eastward in the Himalaya, occurs in the Khasia, and perhaps the *Chamærops* may be the same as the Khasian species. The *Spiræa Kamtschatica* is a native of Eastern Siberia.

The number of Eastern Himalayan and Khasian forms that

advance no further to the westward will, we do not doubt, prove very much larger, as the following list of species already identified proves :—

Aconitum *palmatum*.
Manglietia *insignis*.
Magnolia *sphenocarpa*.
Michelia *excelsa*.
„ *lanuginosa*.
Sphærostemma *elongatum*.
Stephania *hernandifolia*.
Berberis *Wallichiana*.
„ *angulosa*.
Meconopsis *simplicifolia*.
„ *Nipalensis*.
„ *Wallichii*.
Corydalis *juncea*.
Pyrus *Indica*.
„ *foliolosa*.
Cotoneaster *rotundifolia*.
Eriobotrya *elliptica*.
Photinia *dubia*.
„ *integrifolia*.
Rubus *rugosus*.
„ *calycinus*.
Cerasus *rufa*.
„ *acuminata*.
Neillia *thyrsiflora*.
Sanguisorba *decandra*.
Panax *Pseudo-ginseng*.
Hedera *polyacantha*.
Toricellia *tiliæfolia*.
Wightia *gigantea*.
Schœpfia *fragrans*.
Gaultheria *fragrantissima*.
Pieris *formosa*.
Edgeworthia *Gardneri*.
Eriosolæna *Wallichii*.
Cinnamomum ? *caudatum*.
Benzoin *Neesianum*.
Phœbe *paniculata*.
Tetranthera *sericea*.
„ *elongata*.
„ *oblonga*.
Sphærocarya *edulis*.
Helicia *robusta*.
Corylus *ferox*.
Quercus *serrata*.
„ *Arcaula*.
„ *lamellosa*.
Podocarpus *macrophylla*.
Larix *Griffithii*.

A considerable number of tropical forms also creep along the base of the Himalaya as far west as the valley of Nipal, which have not been collected in Kumaon or west of it, as :—

Dillenia *speciosa*.
„ *aurea*.
Saccopetalum *tomentosum*.
Parabæna *sagittata*.
Cocculus *mollis*.
Castanea *Indica*.

and a species of Calamus.

Western Himalaya.

The mean elevation of the western Himalaya is not mate-

rially less than that of the eastern, for the passes over the principal chains are quite as lofty, though none of the peaks attain the extreme altitude of Kanchinjanga or Dhawalagiri. The highest mountain west of Nipal is Nanda Devi in Kumaon, 25,750 feet, but there are many peaks above 20,000 in all parts of the range. The last great peak is Dayamar, north-west of Kashmir, the height of which is 20,000 feet, beyond which the chain dips rapidly to the Indus.

The main chain of the western Himalaya, commencing near the great peak of Kailas, north of the lake Mansarowara, runs to the south of and parallel to the Indus, which it separates first from the Satlej, then from the Chenab, and latterly from the Jelam. To the eastward this chain is entirely Tibetan, but north-west of Piti it separates Lahul and Kishtwar from the Tibetan districts of Parang and Zanskar; still further west it separates Kashmir from Dras, and finally terminates at the great bend of the river Indus.

The primary ramifications of the main chain are three in number. One (the Cis-Satlej Himalaya) is given off close to the great lakes, and separates the Satlej basin from that of the Ganges and its tributaries, terminating in the plains of Hindostan near Nahan. A second (the Cis-Chenab Himalaya) branches off from the main chain near the lake Chumoreri in Tibet, and separates the basin of the Chenab from those of the Beas and Ravi, terminating in the plain of the Panjab a little east of Jamu. The third principal branch of the chain separates the Chenab from the Jelam.

Our knowledge of the Western Himalaya is so much more definite than that which we possess regarding Nipal and the eastern provinces, that it is necessary to adopt a more minute subdivision. The following districts will be frequently referred to, and described in detail at a future page:—

1. Kumaon.

2. Garhwal.

3. Simla; including Sirmur and Basehir and a number of petty states, extending from the Jumna to the Satlej.

4. Kunawar; the upper part of the Satlej basin to the Tibetan districts of Piti and Guge.

5. Kulu; including Mandi and other petty states in the basin of the Beas.

6. Chamba; the basin of the Ravi.

7. Lahul; the highest and subtibetan course of the Chenab.

8. Kishtwar; the middle part of the Chenab basin.

9. Jamu; the lower part of the Chenab basin, including Banahal.

10. Rajaori; the states between Kashmir and the plains.

11. Kashmir.

12. Hazara or Marri.

In consequence of the increased distance from the sea, and partly also from the great obliquity of many of the great mountain ranges, the rain-fall in the Western Himalaya is much less considerable than it is in the Central and Eastern. The rain-fall also diminishes, *cæteris paribus*, regularly and gradually from east to west, but the amount varies so much with local circumstances that, unless used with proper caution, absolute numbers are apt to mislead. Thus, while the average rain-fall at Naini Tal, elevated 6500 feet on the last spurs of the Gagar overhanging the plains of Rohilkhand, is 88 inches, at Almora, elevated 5500 feet, but fifteen miles further from the plains, only 34 inches fall. The fall at Naini Tal may however be compared with that of Dorjiling (125 inches), for in both these localities there is no considerable amount of higher land interposed between them and the plains of India. The rain-fall at Masuri and at Simla is materially less.

The vegetation of the Western Himalaya alters with the climate, presenting a very gradual transition from the flora of Nipal to that of the arid Afghan hills. This is the case equally in the tropical, temperate, and alpine zones of vegetation, and in the interior as well as in the exterior Himalaya.

In the tropical zone of Kumaon a dense forest skirts the base of the mountains, corresponding in all its features with

that which we have indicated as prevalent in similar localities in Nipal. The forest is most luxuriant where the higher mountains overhang the plains, and becomes stunted or disappears entirely where a great river debouches on the plain. In Garhwal, west of the Ganges, the forest which skirts the Siwalik hills is less extensive, but many parts of the Dehra Dhún are densely wooded. A species of *Calamus* which grows in its jungles marks the western limit of that genus along the Himalaya. West of the Jumna the vegetation changes rather suddenly. A similar change has already been indicated at the same place in the plain's vegetation (page 161), but the forest belt close to the mountains, being always more humid than the plain at a distance from them, their vegetation is never the same. The gigantic *Bombax*, and the lofty trees of *Nauclea, Lagerstrœmia, Conocarpus, Terminalia, Sterculia,* and others, and the scandent species of *Butea, Bauhinia, Millettia, Ventilago,* etc., have however disappeared, and spinous bushes or stunted trees of *Zizyphus Jujuba, Butea frondosa, Cassia Fistula, Acacia Arabica* and *Catechu,* form the greater part of the jungle, mixed with *Diospyros cordifolia, Adhatoda Vasica,* and *Isora corylifolia.* In the extreme west, *Acacia modesta* becomes very abundant, and beyond the Jelam the flora is identical with that of the lower Afghan hills.

The tropical vegetation advances far within the mountains, ascending the valleys of the great rivers, and corresponding in character with the forest belt without, but often rather drier. In eastern Kumaon the humid valley of the Sarju is filled with dense forest. The curious palm *Wallichia oblongifolia* has there its western limit, and a pepper, a *Pothos,* an arborescent *Aralia,* and a few other plants indicative of humidity, still linger in its recesses. The valley of the Ganges is much drier and contains little forest, and the tropical portions of the Jumna and the Satlej are quite bare. In the Satlej valley, Afghan forms, unknown further east, begin to make their appearance,—*Paliurus* and *Olea cuspidata* being the most conspicuous. To these are added, in the Chenab

valley, *Acacia modesta, Zizyphus Lotus,* and a spiny *Celastrus,* which west of the Jelam form the great mass of the tropical vegetation. Of tropical fruits, the orange and plantain are cultivated in all the hot valleys of the Panjab Himalaya; and the mango extends to the Indus, and perhaps beyond it. The pomegranate, both wild and cultivated, is abundant in the subtropical jungles, even as far west as Lower Kishtwar.

In the temperate zone of the outer Western Himalaya, the commonest trees of the drier exposures are *Rhododendron arboreum, Andromeda ovalifolia, Quercus incana* and *dilatata;* and the prevailing shrubs are species of *Berberis, Rosa, Spiræa, Rubus.* All of these occur throughout the whole of the chain from Kumaon to the Indus, but to the westward they seem restricted within gradually narrower limits, and in the extreme west are found only in moist and shady woods, which in Kumaon and Garhwal they carefully avoid. To the eastward they are accompanied by many other trees which gradually disappear: thus *Quercus lanata* and *Betula cylindrostachya* are not found west of the Ganges, and *Carpinus viminea* has not been observed west of the Satlej.

In the valleys of the temperate zone and on the lower slopes of the hills the forest is usually very different: *Celtis, Alnus, Populus ciliata, Prunus Padus, Æsculus,* and two species of *Acer* are common trees as far west as the Jelam, or perhaps the Indus. Most of them indeed seem to occur in the humid forests of the Hindu Kúsh, north of Jelalabad. *Benthamia floribunda* and a *Hydrangea* extend from the Eastern Himalaya as far as the Satlej, but have not been found further west, and many species of *Lauraceæ* advance to the Indus.

The influence of climate is much more perceptible on the herbaceous vegetation of the temperate region, and especially on the annual plants which spring up during the rainy season, than on the trees and larger shrubs, which may be presumed to have greater powers of resistance. Hence the *Scitamineæ,* epiphytical and terrestrial *Orchideæ, Araceæ, Cyrtandraceæ,*

Melastomaceæ, and *Begoniæ*, which form so conspicuous a part of the vegetation of the humid eastern Himalaya, occur in very small numbers in Kumaon, rapidly diminish to the westward, and scarcely extend beyond the Satlej. *Streptolirion* and *Adenocaulon*, two of Mr. Edgeworth's most remarkable discoveries in the Simla Himalaya, which there find their western limit, are in like manner Sikkim forms. *Balanophora* also extends west as far as the Satlej, while *Colquhounia* and *Heterophragma* have not been found west of Kumaon.

The cultivation of fruit-trees affords a remarkable exemplification of the difference between the climate of the Eastern and Western Himalaya. In Sikkim no European fruit of any kind, save the strawberry, comes to perfection; even the peach, the only commonly cultivated tree, does not ripen its fruit, and the apricot, the most abundant Western Himalayan fruit, is unknown. In central Nipal, apples, figs, peaches, quinces, and apricots, all ripen, but hardly arrive at perfection. Towards the interior of Kumaon apricots and all the above fruits become abundant, with the pear and cherry; and from Kumaon westward, vineyards and large orchards form a conspicuous feature in the scenery of all interior temperate valleys.

Of the cerealia, Wheat and Barley are the staple crops (as throughout Northern India); the various millets and rice are however cultivated in hot valleys at all elevations below 5–6000 feet, with occasionally maize and sugar-cane. Buckwheat is grown at 5–8000 feet, and the various *Amaranthaceæ* of the Eastern Himalaya extend also to the Western. The cultivation of Tea on the slopes of the outer ranges of Kumaon and Kulu appears to be increasing with great rapidity, and promises to be eminently successful.

The coniferous trees which are common to the Eastern and the Western Himalaya are—1. *Pinus longifolia*, which is found on drier exposures from 7000 as low as 2000 feet, and extends to the mountains of Hindu Kúsh. 2. *P. excelsa*, which occurs in all parts of the Himalaya (except Sikkim),

as well as in Balti (in Western Tibet) and in Afghanistan. 3. *Abies Smithiana,* which also inhabits all parts of the Himalaya, extending into Afghanistan. 4. *A. Brunoniana,* which is not found further west than the upper part of the valley of the Kali, in Eastern Kumaon. 5. *Picea Webbiana,* the most alpine of all the species which ranges from Bhotan to Kashmir: it covers the mountains, between 8000 and 12,000 feet, with a sombre forest, appearing equally at home in the humid climate of Sikkim and on the arid mountains of Upper Kunawar. 6. *Juniperus recurva.* 7. *J. Wallichiana.* 8. *J. excelsa.* 9. *Taxus baccata.* The two first of the junipers, and the yew, are found in all parts of the Himalaya.

Two species only are confined to the Eastern Himalaya, namely, *Larix Griffithii* and *Podocarpus macrophylla;* but *Pinus Sinensis,* so common in Khasia, will perhaps prove to be a native of Eastern Bhotan. The Western Himalaya has four species which are not found in Nipal or the Eastern Himalaya. These are—1. *Pinus Gerardiana,* a native of Afghanistan, of Hasora, north of Kashmir, and of the drier valleys of the Himalaya as far as the Satlej. 2. *Cedrus Deodara,* which is scarcely indigenous in Eastern Kumaon, and ranges from Garhwal to Afghanistan. The deodar is closely allied to, if not identical with the cedar of Lebanon, which extends from Syria and the Taurus to the Atlas mountains. 3. *Cupressus torulosa,* which is probably the wild state of the common cypress; it is a rare plant in the Himalaya, but is found at Niti, near Simla, and at Naini Tal, and may perhaps occur in Western Nipal. 4. *Juniperus communis,* found in all the drier parts of the chain from Afghanistan and Kashmir to Kumaon.

There is no abrupt transition from the flora of the outer temperate Himalaya to that of the interior. The amount of rain-fall diminishes very gradually as we ascend the great valleys, and the diminution of humidity is accompanied by the appearance of new types of vegetation. This transition is most observable in the Satlej and Chenab valleys, which lie so

obliquely to the axis of the chain that they have a long course through a moderately dry climate. The valleys of the other rivers (except the Jelam) are much more perpendicular to the axis, and the humid vegetation passes almost immediately into an alpine and Tibetan flora, without the intervention of a dry temperate flora.

It must not be supposed that the vegetation of the interior temperate Himalaya is altogether, or even in a great measure, different from that of the outer ranges. A very large proportion of the species is the same throughout both regions, consisting of western forms, to which even heavy rain at one season is not injurious so long as a great portion of the year is dry, but whose progress to the east is stopped as soon as the humidity becomes permanent. The rains' vegetation of the outer mountains is, however, entirely absent from the interior, and its place is taken by such Tibetan forms as are not entirely intolerant of moisture. The presence of *Pinus Gerardiana*, *Ephedra*, *Quercus Ilex*, *Ribes Grossularia*, and *Dianthus*, may be considered as indicating that the rains are very trifling in amount in average seasons. *Pinus longifolia* disappears, with *Rhododendron arboreum* and its associated plants; but all the other pines continue to the upper limit of trees, or to the borders of Tibet. The cultivation of the vine is only carried on in this inner region, the rainy season of the outer mountains preventing the ripening of grapes.

West of the Ravi the rain-fall has so much lessened even on the outer hills, that it is only on the first range which rises into the temperate zone, that the normal West Himalayan vegetation (*Quercus incana*, etc.) occurs; while the valleys immediately north of it, when sheltered by hills rising continuously to 9000 or 10,000 feet, present many of the features characteristic of the interior Himalaya. The presence or absence of *Quercus incana*, *Rhododendron arboreum*, and *Andromeda ovalifolia*, on the one hand, and of *Pinus Gerardiana* and *Ephedra* on the other, may be regarded as a fair criterion of the two extreme climates; but there are many valleys in

the extreme west from which both classes of plants are absent, or in which these exterior Himalayan trees are found along with forms common in Kunawar and Kishtwar. *Fothergilla involucrata* (first observed by Falconer, in Kashmir) is a curious instance of a tree plentiful in all parts of the temperate zone, from Kashmir to the Ravi, but not found further east.

The alpine flora of the Western Himalaya presents the same gradual transition from humid and eastern types to the characteristic forms of Western Asia, which we have observed in the tropical and temperate zones. The mountains of Eastern Kumaon are rich in beautiful Nipal forms, such as *Cyananthus*, *Meconopsis*, *Codonopsis*, various gentians, saxifrages, and many others; but their number rapidly diminishes as we advance westward, and the vegetation of the higher Alps of Kashmir is almost identical even in species with that of the mountains of Afghanistan, Persia, and Siberia.

For our earliest knowledge of the vegetation of the Western Himalaya we are indebted to Dr. Govan, who seems to have explored some parts of Sirmur and Garhwal, and to General Hardwicke, who travelled in Garhwal and communicated plants to Roxburgh and Wallich. The Wallichian Herbarium contains specimens from both these travellers, and also from the Gerards, who collected in the Simla hills and in Kunawar. Dr. Wallich's travels extended only to Hardwar and Dehra Dhún, but he also distributed extensive collections made in the interior of Kumaon by Blinkworth and others.

The list of botanists who have investigated the flora of the Western Himalaya, includes the names of Royle, Jacquemont, Falconer, Griffith, Munro, Edgeworth, Madden, Strachey, Winterbottom, and Fleming; but we have already (pp. 60–70) entered into such details regarding their labours, as to render it unnecessary to dwell upon them here. Mr. Edgeworth collected in Kumaon, Garhwal, Simla, and Kunawar, and he has recently communicated to the Hookerian Herbarium a valuable set of plants from Chamba and Kulu, and

an interesting collection made by Captain Hay in the little known district of Lahul.

The botanical provinces of the Western Himalaya may be divided into two principal groups, characterized both by their climate and geographical position. Of these, the first group consists of seven provinces, all bounded on the south by the plains of India, and through which the Himalayan rivers that water them flow in a direction at right angles to the course of the mountains. The second group of provinces consists of five beyond the Satlej, most of which lie to the northward of the first group, and follow a line parallel to them. These are the upper valleys of some of the same rivers as flow through the first group of provinces, and owe their existence as distinct regions in physical geography to the fact elsewhere indicated (page 168), that the courses of the upper parts of the larger rivers of the Western Himalaya are parallel to the axis of the chain.

The great elevations of the secondary chains (or spurs of the main chain) that divide the upper group of provinces from the lower, forming the southern boundary of the upper, prevents the access of humid winds to them, which, together with the greater elevation of their valleys, makes their climate very different.

It is to be borne in mind that the necessity of thus dividing the North-western Himalaya beyond the Satlej into two parallel lines of provinces does not indicate any great difference between this part of the Himalaya and that to the eastward; for, as we have repeatedly remarked, the heads of all the larger Himalayan rivers are in an arid climate. The upper valleys of most of these rivers are too small to constitute provinces, but it cannot be doubted that when the physical features of such large rivers as the Subansiri, Aran, etc., come to be explored, their upper valleys will be found to constitute provinces with a climate and vegetation intermediate in character between those of the Himalaya and Tibet.

The two groups of provinces of the Western Himalaya we propose are :—

First Group.	Second Group.
1. Kumaon.	8. Kunawar (north of Simla).
2. Garhwal.	9. Lahul (north of Kulu).
3. Simla.	10. Kishtwar (north of Chamba and Jamu).
4. Kulu.	11. Kashmir (north of Rajaori).
5. Chamba.	12. Marri (between the Jelam and Indus).
6. Jamu.	
7. Rajaori.	

The observations we have to offer upon the vegetation of these are very fragmentary, as the majority of the natural orders have still to be worked out; we shall however endeavour, after describing the physical features of each, to give as many examples as we can of the peculiarities of their floras, as will show the importance of the study and the means of prosecuting it. Their complete elucidation must be left for local botanists.

1. Kumaon.

Kumaon, as at present limited, is bounded on the east by the Kali, separating it from Nipal; on the west by the Alaknanda branch of the Ganges, and its western feeder, the Mandakni; on the north by the axis of the Cis-Satlej Himalaya, and on the south by the upper Gangetic plain. The elevation of the Terai at its base varies from 600 to 1000 feet; the mountains of the outer ranges rise to 7000 in many places, and in the interior attain 10,000, while still further north many rise above 20,000, and a few above 24,000 feet. The loftiest, as elsewhere in the Himalaya, are never on the axis of the chain, which is still further north, and whose great mean elevation may be judged of from that of the passes over it. Of these, proceeding from the eastward, the Lankpya Pass is 18,000 feet, the Lakhur 18,400, the Balch 17,700, the Niti 16,800, and the Mana 18,760. Almora, the capital

of the province, is elevated 5500 feet, the lake of Naini-tal 6500, of Bhim-tal 4000. Binsar, a mountain of the interior region and a well known botanical station, is elevated, we believe, about 7500.

For further particulars we must refer to Captain R. Strachey's account of the provinces of Kumaon and Garhwal in the Journal of the Geographical Society of London (May, 1851).

The vegetation of Kumaon appears to afford rather a rapid transition from the humidity of Nipal to the drier provinces further west. Its flora, according to Strachey's and Winterbottom's excellent collections, includes fully two thousand flowering plants,—a much larger number than are to be found in an equal area anywhere to the westward, though considerably fewer than to the eastward.

Amongst the natural orders we have examined in detail, the following species find their eastern limit in Kumaon, so far as is at present known:—

Thalictrum *pauciflorum.*
Oxygraphis *polypetala.*
Ranunculus *hirtellus.*
„ *arvensis.*
Trollius *acaulis.*
Aquilegia *vulgaris.*
Delphinium *denudatum.*
„ *incanum.*
„ *ranunculifolium.*
„ *Kashmirianum.*
Aconitum *Lycoctonum.*
„ *heterophyllum.*
Pæonia *officinalis.*
Papaver *dubium.*
Meconopsis *aculeata.*
Corydalis *Govaniana.*
„ *flabellata.*
Pyrus *baccata.*
Rosa *pimpinellæfolia.*
Rubus *saxatilis.*
Potentilla *alpestris.*
Geum *urbanum.*
Spiræa *sorbifolia.*
Daphne *oleoides.*
Celtis *eriocarpa.*
Corylus *Colurna.*
Quercus *lanata.*
Cedrus *Deodara.*
Cupressus *torulosa.*
Juniperus *communis.*

Of Eastern Himalayan plants which have not hitherto been traced to the westward of Kumaon there are:—

Clematis *grewiæflora.*
„ *acuminata.*
Thalictrum *elegans.*
„ *glyphocarpum.*

Thalictrum *Punduanum*.
Oxygraphis *glacialis*.
Ranunculus *flaccidus*.
Trollius *pumilus*.
Magnolia *Champaca*.
Michelia *Kisopa*.
Miliusa *velutina*.
Sabia *parviflora*.
Corydalis *chærophylla*.
Rubus *reticulatus*.
" *paniculatus*.
" *peduncularis*.
Potentilla *polyphylla*.
" *monanthos*.
Cerasus *Nipalensis*.
Hedera *serrata*.
" *æsculifolia*.
" *terebinthacea*.
" *parasitica*.
Aralia *Leschenaultii*.
Panax *fragrans*.
Olax *nana*.
Camphora *glandulifera*.
Phœbe *pallida*.
" *lanceolata*.
Litsæa *lanuginosa*.
Dodecadenia *grandiflora*.
Daphnidium *pulcherrimum*.
" *bifarium*.
Goughia *Himalensis*.
Henslovia *heterantha*, Bl.
Salix *Lindleyana*.
Elæagnus *conferta*.
Carpinus *viminalis*.
Castanea *tribuloides*.
Abies *Brunoniana*.
Wallichia *oblongifolia*.
Chamærops *Martiana*.

2. Garhwal.

This province, which is bounded on the west by the Tons, presents a continuation of the physical features of Kumaon, though it is on the whole a less elevated country, and consists chiefly of the basins of the Bhagiratti and Jumna rivers. Its comparatively short northern frontier is formed by the continuation of the Cis-Satlej chain, and, judging from the elevation of the principal passes (15,000 to 16,000 feet), its mean elevation is not much less than Kumaon. The level of the plains at the foot of the hills is 1000 feet, both at Hardwar and Saharunpore, and of the Dehra Dhún, within the first range of hills, 2300 at the village of Dehra. The station of Masuri is 7000 feet; Kedarnath, a well-known botanical station in the interior, is 11,800; the valley of the Bhagiratti at Tirhi, 2300; and Khalsa, at the junction of the Tons and Jumna, is only 1700. There are few plants common to Ku-

umaon and Garhwal that are not also found in Simla; those that have hitherto occurred to us are—

Delphinium *cæruleum.*	Stranvæsia *glaucescens.*
Clematis *Nipalensis.*	Rosa *sericea.*
Aconitum *ferox.*	Rubus *biflorus.*
Berberis *umbellata.*	„ *alpestris.*
Gaultheria *repens* (*nummularia,* Don).	„ *nutans.*
	Potentilla *microphylla.*
Monotropa *uniflora.*	Hedera *tomentosa.*
Pieris *villosa.*	Cinnamomum *albiflorum.*
Celtis *Roxburghii.*	Tetranthera *Roxburghii.*
Antidesma *diandrum.*	„ *monopetala.*

Of Western Himalayan plants that have not been recorded as natives of Kumaon, but are natives of Garhwal, there are—

Clematis *grata.*	Corydalis *crithmifolia.*
Berberis *Lycium.*	Cotoneaster *vulgaris.*

3. Simla.

We have applied the name (already well known to botanists) of Simla to the whole district west of the Tons and east of the Satlej, including Basehir, Sirmur, and numerous petty states. It is composed principally of ranges given off from the rapidly declining Cis-Satlej branch of the Himalaya chain, which sweeps to the southward and westward, between the valleys of the Satlej and Tons. The axis of this chain, at the northern boundary of Simla, separates that province from Kunawar, and is crossed by the Burenda and Shatul passes, which being respectively 15,179 and 15,560 feet, indicate an elevation of the axis scarcely lower than in Garhwal.

The plains at the foot of the Simla hills attain 1000 feet elevation, and the outer ranges are lower than those of Garhwal and Kumaon. Rupar, close to the Satlej amongst the outer hills, is under 1000 feet; Sabathu, a little further in, is 4200; Kassowlee 6500.

At Simla, which is situated on the main (Cis-Satlej) chain,

the elevation of the latter is 7000–8000 feet; a little further north it rises at Nagkunda to 9300, and to 10,700 at the Peak of Hattu. Chor mountain, situated on a branch of the main chain, only thirty miles from the plains, and a well known botanical habitat, is 12,100 feet, and is one of the most remarkable isolated peaks in the Himalaya. The bed of the Satlej is everywhere very low, being at Belaspur 1500, and at Rampur 3300 feet.

The flora of Simla may be considered as exceedingly well known; it presents a considerable proportion of Eastern Himalayan plants that do not appear to cross the Satlej basin, and a smaller one proportionally of western species not found in Garhwal.

Western Species.

Thalictrum *pedunculatum.*	Adonis *æstivalis.*

Eastern Species.

Clematis *nutans.*	Antidesma *paniculatum.*
Thalictrum *rostellatum.*	Betula *cylindrostachya.*
Ranunculus *diffusus.*	Alnus *Nipalensis.*
Delphinium *vestitum.*	Myrica *sapida.*
Sphærostemma *grandiflorum.*	Cupressus *torulosa.*
Stephania *rotunda.*	Potentilla *fulgens.*
Hollböllia *latifolia.*	„ *leuconotha.*
Dicentra *Roylei.*	„ *Kleiniana.*
Benthamia *fragifera.*	Sibbaldia *potentilloides.*
Daphne *papyracea.*	Sieversia *elata.*
Osyris *arborea.*	Cerasus *Puddum.*

In the tropical valley of the Satlej the vegetation resembles that of the outer hills, and dry country forms predominate, as *Colebrookia, Rœttlera,* and *Euphorbia pentagona;* whilst Bamboos, *Butea, Ægle Marmelos, Moringa pterygosperma, Capparis sepiaria,* and *Calotropis,* seem altogether absent, or are very rare.

4. Kulu.

This province consists of the mountain basin of the Beas,

and the west bank of the Satlej, and may be made to include the subtropical districts of Mandi and Suket, Nadaon and Kangra. It presents no features not common to Chamba, the next succeeding province to the north-west. Sultanpur, the capital, is 5000 feet. Kangra Fort, situated a short way within the outer ranges, is a British station, and the hills around it are extensively planted with tea. Dharmsala, above Kangra, is a sanitarium, elevated about 6000 feet. The chain bounding the Satlej on the west is considerably higher than that on its east bank, and is crossed into Suket by the Jalauri Pass, elevated 12,000 feet.

Mr. Edgeworth is the only botanist who has investigated the flora of this province, and he has (since the printing of p. 70 of this Essay) communicated a valuable collection to Sir W. Hooker's Herbarium.

5. Chamba.

Chamba, the next province to Kulu, is altogether like it in physical features, and consists of the mountain basin of the Ravi. It has been traversed by Dr. Thomson, who entered it from the north-west, by the Padri Pass, elevated 11,000 feet, over the chain dividing it from Jamu; thence he descended to the Ravi, in the centre of the province, where its bed is elevated less than 5000 feet; and travelling northward, left it by the Sach Pass, elevated 14,800 feet, over the range dividing it from Kishtwar.

The vegetation of Chamba appears to present few peculiarities, amongst which we may notice the appearance of *Cratægus Oxyacantha*, which here finds its eastern limit; *Litsæa consimilis*, *Rhododendron lepidotum*, and *Sibbaldia purpurea* have not hitherto been detected further to the west. *Fothergilla involucrata* is a curious example of a plant suddenly appearing most abundantly, and continuing so for several provinces to the westward.

6. Jamu.

Under this name we include the lower part of the Chenab valley, to the plains of the Panjab, Banahal on the southern slopes of the chain bounding Kashmir on the south, Badarwar on the confines of Chamba to the east; whilst to the north, this province passes into that of Kishtwar, which may be said to commence where the course of the Chenab changes from north-west to south-west. Though probably differing little in physical features from Chamba on the east, it is known much better, from having been traversed in several directions by botanists.

The bounding mountains of Jamu attain an average elevation of 12–14,000 feet; the Banahal Pass to Kashmir is 10,000 feet; that of Padri into Chamba has already been given as 11,000 feet; the bed of the Chenab is a little above 1000 feet near Jamu, and that town itself is 1500 feet.

The outer ranges of sandstone hills rise gradually from the plains of the Panjab (elevated 1000 feet), and are covered with a loose scrub of tropical, dry country, both eastern and western forms, as *Dodonæa, Rœttlera, Rondeletia, Phœnix sylvestris, Pinus longifolia, Solanum Jacquini,* Sissoo, *Celastrus, Zizyphus,* Mango and Pepul, *Cassia Fistula, Rhus, Salix tetrasperma, Coriaria, Bauhinia Vahlii, Euphorbia pentagona, Cocculus laurifolius.* In the temperate region, the prevalent Himalayan forms of Simla appear in much reduced numbers, with *Fothergilla, Quercus incana, Andromeda ovalifolia, Rhododendron campanulatum,* and *Sabia campanulata.* Besides these, *Quercus dilatata, Q. semecarpifolia,* and *Rhododendron arboreum,* which hardly occur further west and do not enter Kashmir, are all found in Jamu.

Of plants which probably do not occur much, if at all, further west than the Jamu hills, are—

Rhododendron *campanulatum.*	Phœnix *sylvestris.*
,, *arboreum.*	Prinsepia *utilis.*
Gualtheria *trichophylla.*	Rubus *flavus.*

Rubus *purpureus.*	Spiræa *betulæfolia.*
„ *maculentus.*	„ *chamædrifolia.*
Potentilla *atro-sanguinea.*	„ *sorbifolia.*

Of the western forms not hitherto collected to the eastward of Jamu, are *Rubus fruticosus* and *Potentilla desertorum.*

7. Rajaori.

Under this term we include the province of that name, and all the hill states south of Kashmir, and between the Jelam on the north-west and Jamu on the south-west; thus including the left bank of the Jelam river from where it leaves Kashmir to the plains of the Panjab.

The vegetation of the lower hills of this province has been noticed under the Panjab; that of the upper appears, so far as it is known, to be identical with that of Jamu and Chamba. *Clematis Gouriana,* which extends from Khasia, here finds its western limit.

8. Kunawar.

Kunawar includes the upper part of the Satlej basin, to the borders of Piti and Guge in Tibet. Its general direction is north-east and south-west; its bounding mountains are, to the south-east, the Cis-Satlej chain, and to the north-west the mountains bounding Piti. To the south-west and north-east the natural boundaries are less defined, and formed by secondary chains from the former. The province is usually divided into upper and lower Kunawar, the former approximating in climate to Piti.

The mountains which descend from the two parallel bounding chains of Kunawar to the Satlej are very lofty; they are crossed in the usual route to Tibet by the Werang Pass, 13,200, and the Runang Pass, 14,500; the passes over its southern bounding chain are the Shatul Pass, across the Cis-Satlej, leading to the Simla province, elevated 15,560; and the Kuibrang, over a more northern branch of the same, and

which divides Kunawar from Tibet, is 18,300. To the north, the pass leading from Kunawar into Piti is the Hangarang, 14,800. Those to Upper Piti are much more lofty. The bed of the Satlej ascends from about 4000 feet in Lower Kunawar, to 8000 or 9000 feet at the upper extremity of the province.

As a whole the province is very dry, compared with any to the southward and eastward of it, being intermediate in this respect, as it is in geographical position, between the Tibetan and Cis-Himalayan provinces, and its flora is consequently comparatively poor in number of species. Owing to the dryness of its climate, Kunawar is sometimes selected as a retreat from the rains of Simla; and the village of Chini, elevated about 7000 feet, has thus been often visited. Plants from this province and the adjacent districts of Tibet are frequently said to be gathered in Chinese Tartary,—an unmeaning term, and one which should be disused in geographical and botanical works. Owing to the rapid transition from the climate of the humid parts of the Simla province to that of Kunawar, we have few instances to record of eastern forms finding their limits here: amongst which there are, perhaps, *Berberis aristata, Cassiope fastigiata, Potentilla fruticosa, P. eriocarpa,* and *P. ambigua;* and no doubt some others lurk in the more humid and shaded situations.

On the other hand, many remarkable western and Siberian forms make their appearance in Kunawar, which advance no further east. As—

Clematis *parvifolia.*	Quercus *Ilex.*
Rubus *purpureus.*	Olea *cuspidata?*
Salix *acutifolia.*	Dianthus.
Alnus *nitida.*	Paliurus *aculeatus.*
Pinus *Gerardiana.*	Eremurus *Biebersteinii.*

Whilst many species, which have been hitherto known only as natives of the dry Tibetan climate at the heads of the Himalayan rivers, become prevalent features in the flora.

The first remarkable local transition in the vegetation is

met with on the road between Chegaon and Miru, in Lower Kunawar; but, though striking to the eye, from the prevalence of a few novel forms of plants, the total number of new species, not found commonly in Simla, amounts only to thirty or forty. Of the latter, a small-leaved ash, *Dianthus, Lychnis*, and various *Alsineæ, Artemisias* and *Leguminosæ*, contribute most to the altered character of the flora.

Of cultivated plants, the grape, apricot, all *Pomaceæ*, walnut, etc., thrive in Kunawar, and most of them better than anywhere to the eastward, but all are equally prevalent to the westward. Their abundance, together with the beauty of the scenery of Kunawar, which is extolled by every one, the delicious climate of its almost rainless summer, and its being on the high road to Tibet, Yarkand, and Central Asia, will all contribute to render it one of the most attractive spots in our Indian possessions.

9. Lahul.

Lahul, a British province, is included by Cunningham in Tibet, from which it is however distinct in its physical features. It consists of the valleys of the head-waters of the Chenab. Of its vegetation we know very little, except from an interesting collection formed by Captain Hay, and communicated by Mr. Edgeworth, which we have not yet had time to examine. It is everywhere surrounded by lofty mountains, except towards its north-western extremity, where it is conterminous with Kishtwar. To the south it is bounded by the mountains north of Kulu, where it is crossed by the Rotang Pass, elevated 13,200 feet, an exceptional depression, the rest of the chain being very lofty. To the west, a portion of the Himalayan axis divides it from the Tibetan province of Piti, and is crossed by the Kulzum Pass, elevated 14,850 feet; and to the north, a continuation of the same axis separates it from the Tibetan province of Zanskar, and is crossed by the Baralacha Pass, elevated 16,500 feet.

Thus hemmed in by lofty mountains, the vegetation of La-

hul is probably very scanty, and nearly Tibetan in character; but pines occur even up to 11,000, and it is far more fertile than any Tibetan province. The bed of the Chenab is probably nowhere below 8500 feet elevation, and the plants must therefore be all temperate and alpine. A wild yellow Persian rose, a variety of *R. eglanteria,* here finds its eastern limit.

10. Kishtwar.

Kishtwar includes the middle course of the Chenab valley between Lahul and Jamu. It is separated on the north from the Tibetan valleys of Zanskar and Dras by the axis of the Himalaya, which is crossed by the Umasi Pass into Zanskar, elevated 18,000 feet; and by other passes, from Wardwan into Dras, at scarcely less elevations. The district of Wardwan to the west occupies the eastern slopes of the range which separates Kishtwar from Kashmir, and is crossed by the Nabagnai Pass, of undetermined elevation, and probably by several others. To the south, Kishtwar is separated from the Chamba province by a range of 10–14,000 feet elevation, alluded to under that province. The boundary between Kishtwar and Jamu to the south-west is not defined.

The climate and vegetation of Kishtwar, like those of Kunawar, with which they are identical, are in all respects intermediate in general features between those of the plainward Himalayan provinces and of Tibet; and in more local ones between those of the provinces occupying the lower and upper course of the Chenab (Jamu and Lahul) on the one hand, and between Kashmir and these on the other. The elevation of the Chenab at about the middle of the province is from 6000 to 7000 feet, and there is hence scarcely any type of tropical vegetation, except *Paliurus, Desmodium,* and Pomegranates.

In entering Kishtwar by the Chamba province a marked change occurs in the vegetation, from the prevalence of a mixture of Kashmir and Kunawar plants which are rare or not found in the provinces skirting the plains, as a tall paniculate *Rheum,* many *Umbelliferæ, Silene inflata, Geranium,* and

Pteris aquilina, together with *Eremurus* in great abundance. Of other Kunawar plants are *Ephedra, Dictamnus, Rosa pimpinellæfolia, Dianthus,* and *Scutellaria orientalis. Pinus Gerardiana* is very common, with large walnut and other fruit-trees; and the forest vegetation resembles that of Kashmir, with the addition of *Quercus Ilex* and *Pinus Gerardiana.*

Of eastern forms, which do not, so far as we are aware, advance westward into Kashmir, there are *Clematis connata* and *Trollius acaulis.* And of Kashmir and other western forms, not hitherto collected to the eastward, there are—

Anemone *Falconeri.*	Epimedium *elatum.*
Ceratocephalus *falcatus.*	Corydalis *adiantifolia.*

11. Kashmir.

The valley of this name consists of the upper part of the basin of the Jelam; and from its comparatively great width, level floor, abundant population, and cultivation, and from its containing by far the broadest sheets of water known anywhere within the Himalaya, it has been regarded rather as a separate country, different from the Himalaya proper, than as an integral part of that mountain mass, and one of the many series of valleys that it encloses. This erroneous impression has been much diffused from the circumstance of map-makers isolating it by a well-defined oval girdle of mountains, cut off almost entirely from the rest of the Himalaya, but which has no such independent existence. It would be out of place here to dwell upon the geological causes that have filled the Kashmir valley with deposits to the depth of many hundred feet, and which have given rise to its flat surface and its lakes, and which, if present in any of the western valleys, would render that of Kashmir less conspicuous.

Kashmir is bounded to the north by the axis of the Himalaya, which there presents a remarkable depression occupied by the Zoji Pass, elevated only 11,300 feet, and communicating with the Tibetan valley of Dras. To the south, the Pir-Panjal

and Banâhal ranges separate Kashmir from the provinces of Rajaori and Jamu: and the Wardwan range separates it from Kishtwar to the east. The average elevation of the main Himalayan chain north of Kashmir is about 14,000 feet; and of the Pir-Panjal, to the south of it, 12,000; its loftiest summit being 15,000. The Banahal Pass between Kashmir and Jamu is only 10,000 feet. The course of the Jelam is first from south-east to north-west, through the valley of Kashmir, when it turns south-west after leaving the Walur Lake and enters Marri. The elevation of its bed is 5300 feet at Srinagar the capital, and continues so from Islamabad to the Walur Lake, a distance of 50 miles.

Kashmir is not strictly analogous in situation or climate to Kunawar or Kishtwar, but the summer rains are so much interrupted that they can hardly be regarded as the effect of a monsoon. Kashmir contains no *Rhododendron arboreum* and no oaks, nor does it produce *Pinus Gerardiana*. Its flora is a curious mixture of the hot and dry vegetation of Afghanistan, with a few ordinary Himalayan forms on the one hand, and many Persian and Caucasian ones on the other. From its moderate elevation, and the great dryness of the atmosphere throughout the year, the summers are very hot. Rice is the staple crop, and the vine is extensively cultivated. Many of the eastern Himalayan forms which occur in Kashmir extend to Afghanistan, and some even to Persia; but their number is small when compared with those of western origin. Kashmir indeed contains many common European species, which there find their eastern limit.

Of the many western forms that inhabit the valley, the following have not been collected further east in the Himalaya, though a few probably occur in Kishtwar:—

Anemone *biflora*.	Delphinium *penicillatum*.
„ *narcissiflora*.	Nymphæa *alba*.
Ranunculus *Lingua*.	Scutellaria *galericulata*.
„ *chærophyllos*.	Lythrum *Salicaria*.
Isopyrum *thalictroides*.	Cerasus *prostrata*.

Prunus *insititia*.
Potentilla *reptans*.
„ *grandiflora*.
Cotoneaster *nummularia*.
Marrubium *vulgare*.
Salix *purpurea*.
„ *rubra*.

Of the following list of eastern forms some may no doubt be discovered in Marri, and even further west, in Afghanistan:—

Thalictrum *pauciflorum*.
„ *foliolosum*.
Anemone *rupicola*.
„ *rupestris*.
„ *rivularis*.
Ranunculus *hirtellus*.
Delphinium *denudatum*.
„ *incanum*.
„ *ranunculifolium*.
Epimedium *elatum*.
Podophyllum *Emodi*.
Euryale *ferox*.
Pyrus *variolosa*.
Cotoneaster *microphylla*.
Rubus *rosæfolius*.
„ *parvifolius*.
Potentilla *desertorum*.
„ *argyrophylla*.
Spiræa *canescens*.
Osmothamnus *fragrans*.
Salix *elegans*.
Elæagnus *parvifolia*.
Betula *Bhojputra*.
Alnus *nitida*.
Juniperus *recurva*.

Kashmir affords several instances, already mentioned, of anomalous distribution, instanced by the absence of *Andromeda ovalifolia* and *Rhododendron arboreum;* and of oaks, of which five species occur in the adjacent provinces, namely, *Quercus Ilex, annulata, dilatata, incana,* and *semecarpifolia*. Also the appearance of *Salvinia natans,* of *Euryale ferox,* if really wild, and *Nelumbium speciosum,* must be considered as very singular, though the latter is found considerably further north, on the shores of the Caspian. The bullace, *Prunus insititia,* has been found nowhere else in a wild state, except indeed it be a variety of *P. spinosa*. We believe also that the cherry is truly wild in the valley, and it is abundantly cultivated in orchards. The prevalence of these, with Planes, Lombardy Poplars, Walnuts, *Berberis vulgaris, Colchicum, Cratægus Oxyacantha, Actæa spicata, Thalictrum minus, Alliaria officinalis,* and the great majority of the plants men-

tioned at page 109, give an eminently European cast to the whole vegetation.

In the Kashmir lakes many European forms of water-plants occur, which, from the absence of similar expanses in the temperate regions of the Himalaya, are rare or unknown elsewhere; such are *Nymphæa alba,* already mentioned, *Villarsia nymphæoides, Menyanthes trifoliata,* and *Trapa,* besides *Typha, Arundo,* and various *Potamogetons, Sium angustifolium,* several European *Menthas,* etc.

12. Marri.

The Marri range, on the right bank of the Jelam, overhanging the platform of Rawal Pindi, is a narrow ridge separating two deep river-valleys, whose vegetation is quite tropical. On its plainward slope it produces ordinary Himalayan forms (*Rhododendron arboreum,* etc.), but the vegetation soon becomes like that of the hills of Kashmir.

The mountains of Marri properly consist of the western termination of the Himalaya (according to our definition of that chain), which sweeps round the north of Kashmir, and following the course of the Indus, turns to the southward, descending gradually into the plains of the Panjab, its most southern slopes forming the Salt range described at page 156.

Our only knowledge of the plants of Marri is derived from a very valuable collection made by Dr. Fleming, who ascended the ranges to 9700 feet. European forms abound in even a greater proportion than in Kashmir, and many Himalayan plants find there their extreme western limit; such are—

Berberis *Lycium.*	Rosa *macrophylla.*
Delphinium *saniculæforme.*	Rubus *lasiocarpus.*
Quercus *annulata.*	„ *niveus.*
„ *dilatata.*	Potentilla *Leschenaultiana.*
„ *incana.*	„ *Nipalensis.*
Pyrus *baccata.*	Spiræa *callosa.*
Cotoneaster *bacillaris.*	Machilus *odoratissimus.*

The valley of Hasora, north-west of Kashmir, is still more

arid, but not quite Tibetan, *Pinus Gerardiana* being very common. Its flora is, however, scarcely known.

Tibet.

Tibet includes the mountain valleys of the Indus and Yaru (or Brahmaputra), together with the whole axis of the Himalaya and the heads of many of the valleys which descend on the Indian side, and which are situated beyond the mass of snow throughout a great extent of the chain. Beyond the Indus and Yaru are the southern slopes of the Kouenlun, which according to our definition do not form a part of the Himalaya, but of Tibet. Politically its boundary is an irregular one, accidental circumstances having regulated the line of separation between the Indian and Tibetan states. Botanically, the boundary of Tibet is best drawn at the place where the climate becomes too arid to support such a vegetation as flourishes at equal elevations on the Indian watershed, and especially where there is a total absence of forests below 13,000 feet. The flanks of all the great Himalayan rivers, when above 13,000 feet, are, owing to the elevation, devoid of trees, whether the climate be humid or arid; but when their course is oblique, as is the case with the Satlej and the Aran, there are no trees at far lower elevations than this, and a considerable part of their upper course is through a Tibetan climate. Thus, in the valley of the Satlej the climate is too dry for trees at the junction of the Piti river, elevated 9000 feet; and the whole of Piti, as well as the upper course of the Satlej itself, forms part of Tibet. In the valleys of the Ganges and Jumna, on the other hand, whose course is perpendicular to the plains, trees ascend to 10,000 feet, and only the alpine zone is arid and hence belongs to the Tibetan Himalaya, in contradistinction to "Himalaya interior."

Tibet may be divided into two parts, one to the westward (the basins of the Indus and Satlej), the other to the eastward (those of the Yaru and Aran, and perhaps of the Monas, Subansiri, and other rivers). From the position of the Hima-

laya, the rain-fall is much greater at the eastern extremity of the chain than it is to the westward. Hence Western Tibet is considerably drier than Eastern Tibet; indeed, the lower part of the course of the Indus, where that river enters the Panjab plain, is situated in a rainless climate; but the lower part of the course of the Yaru, where under the name of the Dihong it joins the Brahmaputra, lies in one of the rainiest climates of the globe.

The chain of the Kouenlun, where it forms the northern boundary of Western Tibet, is not less elevated than the Himalaya, and is covered throughout a great part of its length with perpetual snow. Its axis has not been crossed by any European traveller, but has been reached by Dr. Thomson, who visited the Karakoram Pass, elevated 18,300 feet. This chain has been called the Mus-tagh, Karakoram, Hindu Kúsh, and Tsungling or Onion mountains (from the prevalence of a species of *Allium*); it is also the Belur-tagh,* which (according to Cunningham) is synonymous with "Balti mountains," and its continuation forms the Pamir range west of Yarkand. In Western Tibet, the axis of this chain is in general distant about 150 miles from the Himalaya, and the country between the two consists of a complication of ranges of lofty and rugged mountains, separated from one another by stony valleys, which on the higher parts of the courses of the rivers expand at intervals into alluvial plains.

The Indus, near its source, has an elevation of 18,000 feet, and where it debouches on the plains of the Panjab it is elevated only 1000 feet. At Le it is 10,500 feet, and at Iskardo 7200 feet. Below 10,000 feet, the summer heat, from the absence of rain, is intense, and the Tibetan flora becomes more Sindian and Persian in character. West of Kashmir and the great peak of Dayamar, the Himalaya diminishes rapidly in elevation, and allows access to the humid atmosphere, which is condensed on the first ranges of Tibet with which it comes

* The Bulut-Tag (or Cloud Mountains) of Captain H. Strachey, who confines the term to the range east of Samarkand and south of Khokand.

in contact. The Tibetan Flora of the Indus, therefore, ends a little below Iskardo, pines appearing in the district of Rondu, and throughout the valley of Hasora, which latter may hence be regarded as not Tibetan.

The mean elevation of Western Tibet exceeds that of all countries of which we have any definite knowledge, and, if not surpassed by part of Eastern Tibet, is without doubt the loftiest area of any considerable extent on the surface of the globe. Captain H. Strachey gives 15,000 feet as the approximate mean elevation; and when we consider that there are throughout Tibet many ranges of a uniform elevation of 19–20,000 feet, and peaks innumerable of 21–25,000, as also that the very lowest level of the Indus valley (itself a mere cleft in the mountain mass) is 6000 feet, the above estimate will not be considered exaggerated. Of the passes over the main axis of the Kouenlun and Himalaya, and over their principal ramifications, far more are above than below 17,000 feet, many are 18,000, and a few 19,000; besides which many extensive areas in Guge, Nari, Nubra, Rupchu, and Zanskar, are continuously above 15,000 feet for many miles in all directions.

The climate of Western Tibet can only be approximately ascertained, no continued records of temperature, humidity of the air, or rain-fall, having ever been kept. Captain H. Strachey has however reduced all the detached observations that were procurable, and we are indebted to his valuable paper on the Physical Geography of Western Tibet* for most of the following data.

In the basin of the Indus at Le, elevated 11,800–12,000 feet, and 1300–1500 above the bed of the river, which is considerably below the mean elevation of Western Tibet, and in a sheltered locality, the mean temperature of the year is assumed to be 35°: of January 10° (variation $-5°$ to $+25°$), and of July 60° (variation 50° to 70°). Constant frost sets in at that elevation early in November, and lasts till the end of February; but night-frosts continue till the middle of April,

* Read before the Royal Geographical Society, November, 1853.

and commence again in the middle of September. A rather sudden rise of temperature attends the vernal equinox, and the summer is comparatively warm, the maximum sometimes, but rarely, reaching 70°.

At 13,000 feet the mean temperature probably coincides with that of the freezing-point. At 14–15,000 feet the summer months alone are free from night-frosts, the maximum temperature is only 60° in good shade, and the winter is proportionately colder than at 12,000 feet; thaw commences at the end of April, the night-frosts are slight by the end of that month, and the mean of the day rises to 50°. At 15,500 feet it probably freezes during every night of the year. At 20,000 to 21,000 feet there is probably perpetual frost in the shade.

These numbers however give no indication of the heat to which vegetation is exposed, for, owing to the rarity of the atmosphere and cloudless skies, the sun's rays have intense power, increasing with the elevation, raising the (white glass) thermometer exposed to them sometimes upwards of 100° above the mean temperature of the air. This, combined with the fact of the temperature of the soil being always above that of the air, fully accounts for the sudden impulse given in spring to the vegetation even in the loftiest and coldest regions. The heat radiated from the naked rocks has also a very powerful effect, especially on the summer crops.

Extreme aridity is the characteristic of all Western Tibet. Rain and snow at moderate elevations are scarcely known, and have no further direct effect on vegetation than is due to the moisture of the soil produced by the melting of glaciers and snow-beds. Dew and hoar-frosts are very rare phenomena. The snow-level is nowhere below 18,000 feet; in the mountains north of the upper Indus valley it rises to 20,000.

Owing mainly to the great drought, the soil is in many places covered with an efflorescence of carbonate and other salts of soda, and salt-lakes are of frequent occurrence. Almost all the large bodies of water indeed are more or less saline, some of them intensely so, especially such as have no outlet,

and are hence gradually drying up. This diminution of many of the lakes is no doubt entirely attributable to a change of climate, which is extremely interesting in a botanical point of view, from its favouring the immigration of many saline types of the Caspian flora.

Where the surface is covered with salt-marshes, are found *Glaux maritima, Eurotia, Corispermum, Caroxylon, Suæda, Salsola, Chenopodium, Ambrina, Christolea, Triglochin;* and a large *Nostoc,* of a species eaten in China, floats on the surface of the pools. The carbonate of soda again appears to have no appreciable effect on the vegetation of the dry soil it encrusts; grasses, tufted *Androsaces, Astragali, Gnaphalia, Artemisiæ,* etc., being alike covered with it.

Cultivation in Tibet attains the height of 15,000 feet, and is luxuriant below 12,000 feet, barley and wheat being the grains cultivated, with rape and millet at lower levels. The indigenous vegetation is everywhere scanty. Though there is no forest, the banks of the rivers and streams are skirted by a dense scrub of bushes, chiefly *Myricaria, Hippophae, Rosa;* and *Lonicera. Populus balsamifera* and *Euphratica,* and *Juniperus excelsa* are the only trees, and these occur rarely; as does *Pinus excelsa,* which is only found towards the confines of Hasora, and can hardly be considered a Tibetan tree. *Myricaria* and *Hippophae* occasionally attain a height of twenty feet. Of cultivated trees, apricots and *Populus balsamifera* are seen up to 12,000 feet; apples, walnut, the black poplar, and *Elæagnus* up to 11,000 feet, pears to 10,000 feet, and grapes and white poplar and plane-trees to 9000 feet.

Subtropical types ascend along the course of the Indus to Rondu and Iskardo, and some of them even as far as 11,000 feet, in Nubra and Le, of which the following genera are examples:—

Capparis.	Echinops.
Peganum.	Tamarix *Gallica.*
Tribulus.	Lycium.
Sophora.	Vincetoxicum.

Plectranthus *rugosus*.
Linaria *ramosissima*.
Cyperus.
Chloris.
Cymbopogon.
Andropogon.
Eriophorum.
Saccharum.
Erianthus.

The temperate vegetation consists almost exclusively of European and Siberian types, and differs remarkably from the Himalayan in the total absence of *Rubi* and *Aconitum*. Besides the shrubs and trees mentioned above, there occur—

Salix *angustifolia*.
„ *zygostemon*.
„ *purpurea*.
„ *acutifolia*.
„ *alba*.
„ *fragilis*.
Perowskia.
Ulmus *pumila*.
Populus *alba*.
„ *nigra*.
Elæagnus.
Betula *Bhojputra*, var.
Loniceræ, several.
Clematis *orientalis*.
Rosa *pimpinellæfolia*.
Artemisiæ, several.
Caragana *versicolor*.
Berberis *ulicina*.
Rhamnus.
Ephedra.

The prevalent natural families are all European:—

Ranunculaceæ.
Fumariaceæ.
Cruciferæ.
Alsineæ.
Leguminosæ.
Rosaceæ.
Umbelliferæ.
Saxifrageæ.
Compositæ.
Scrophulariaceæ.
Labiatæ.
Boragineæ.
Polygoneæ.
Chenopodiaceæ.
Amentaceæ.
Gramineæ.
Cyperaceæ.

The following herbaceous genera and species may be noted as often occurring:—

Ranunculus.
Anemone.
Delphinium.
Thalictrum.
Corydalis.
Hypecoum.
Draba.
Cardamine.
Matthiola.
Sisymbrium.

Stellaria.
Lychnis.
Dianthus.
Astragali, many.
Phaca.
Thermopsis.
Oxytropis.
Cicer.
Potentilla.
Chamærhodos *sabulosa*.
Saxifraga.
Epilobeæ.
Carum *Carui*.
Galium *Aparine*.
Tussilago *Farfara*.
Mulgedium.
Tartaricum.
Artemisia.
Allardia.
Erigereæ.
Aster.
Saussurea.
Gentiana.
Veronica *Beccabunga*.
Agrostis.
Anagallis.
Orobanche.
Euphrasia *officinalis*.
Pedicularis.
Thymus *Serpyllum*.
Menthæ, various.
Dracocephalum.
Primulæ.
Statice.
Orchis.
Herminium.
Allia, several.

The water-plants are *Hippuris vulgaris, Limosella aquatica, Zannichellia palustris, Ranunculus aquatilis* and *radicans, Utricularia,* and several species of *Potamogeton*.

In favourable localities a short turf covers the ground, and affords a nutritious pasturage to yaks, goats, sheep, and horses; this consists chiefly of the common Fescue grass (*Festuca ovina*) and other European species, with several species of *Stipa* and tufted *Carices*.

Owing to the great power of the sun there is scarcely any alpine vegetation, even at 15,000 feet; and above that, though plants may be gathered up to 19,000 feet, vegetation is excessively scanty, and only found by the margins of rills from melting snow. The flora of these regions includes some plants of great interest, as *Papaver nudicaule, Oxygraphis glacialis, Ranunculus hyperboreus, Taraxacum officinale, Delphinium Brunonianum, Berberis ulicina*. A small *Urtica* is everywhere common at great elevations.

The following list of genera and species that occur above

15,000 feet is of course far from complete; those with an asterisk (*) have been observed above 17,000 feet.

Corydalis *Tibetica*.
*Draba *aizoides* and others.
*Parrya.
*Cerastium.
*Lychnis.
*Thylacospermum.
*Myricaria.
*Biebersteinia *odora*.
Oxytropis *chiliophylla*.
*Astragali, several.
Thermopsis.
Potentilla *Salessovii*.
" *anserina*.
* " *Meyeri*.
*Sibbaldia *procumbens*, var.
Chamærhodos *sabulosa*.
*Saxifraga *cernua*.
*Seda.
*Saussureæ, three species.
*Aster *alpinus*.
*Artemisia.
*Leontopodium.
*Allardia.
*Pyrethrum.
Ligularia.
*Nepeta *multibracteata*.
Cynoglossum.
Lithospermum *euchromon*.
*Gymnandra.
*Primula.
Rheum.
Ephedra.
*Carices.
*Stipa.
*Lloydia *serotina*.
*Festuca *ovina*, and other Grasses.

Owing to the aridity of the climate all *Cryptogamiæ* are extremely rare: only three or four Ferns occur; Mosses are scarcely more common, and never fruit. A few crustaceous Lichens, on stones, and half-a-dozen *Fungi*, including several British species, have been collected.

Western Tibet is tolerably well known botanically*. It was first explored by Dr. Falconer, who visited Hasora, Dras, and Balti, and made a fine Herbarium, which is unfortunately still unexamined and undistributed, at the India House. Jacquemont visited Piti in 1830, and Dr. Royle's collectors were there also. Dr. Thomson's collections were made in Piti, Balti, Rupchu, Ladak, Zanskar, Nubra, and Dras. Captain Henry Strachey made an excellent collection in the

* There are a few plants in the Wallichian Herbarium, collected by Moorcroft, the first explorer in modern times of Ladak, and ticketed as from that place, but they are mostly outer Himalayan plants.

mountains round the Pangong lake, and Captain Richard Strachey and Mr. Winterbottom a very valuable one in Guge in the autumn of 1849. Mr. Lance has also sent us, through Mr. Edgeworth, a collection from Piti, Ladak, and Dras, which contains many interesting species.

Our attempts to divide Western Tibet into provinces have been attended with unusual difficulty, owing to the undefined limits of those already established, and to the fact that the natives of that country have no system of nomenclature for large areas, mountain chains, or rivers, available for our purpose. Considering how scanty the flora of Western Tibet is, not amounting perhaps to more than 500 species, and how widely the majority of these are spread, any division into provinces might perhaps have been dispensed with,—so far as the purposes of geographical distribution are concerned; but the flora of the country is far too imperfectly known in detail to warrant the assumption that particular habitats are wholly useless; and we should further be depriving future local botanists of the benefit of our local knowledge.

In the following attempt we have been guided wholly by the river systems, which enable us to divide the country into three parallel lines of provinces, that occupy (within rough limits)—1. The north slope of the Himalaya; 2. The beds of the Indus and Satlej; 3. The south slope of the Kouenlun: they are as follows:—

1. Guge, the Tibetan course of the Satlej.
2. Piti and Parang, the basins of the rivers of those names, tributaries of the Satlej.
3. Zanskar, the basin of the Zanskar river.
4. Dras, the basin of the Dras river.
5. Nari, the upper course of the Indus.
6. Ladak, the middle Tibetan course of the Indus.
7. Balti, the lower Tibetan course of the Indus and of the Shayuk rivers.
8. Nubra, the upper basins of the Nubra and Shayuk rivers, tributaries of the Indus.

1. Guge or Hundes is wholly under Chinese influence, and is comprised between the Himalaya and its Cis-Satlej branch. It extends from the lakes of Mansarowar and Rakastal down the course of the Satlej to Kunawar. The surface of Guge differs remarkably from the rest of Tibet in the greater extent and depth of an alluvial deposit, found elsewhere in Tibet in smaller quantity, and here forming an undulating surface, gradually declining from 15,200 feet, the level of the lakes, to 10,000 feet at the confines of Kunawar. This province, familiarly known as the plain of Tibet, and which has mainly given rise to the erroneous impression of Tibet being a steppe, plain, or table-land, is 120 miles long and 15 to 60 in breadth, and is traversed by the Satlej and its various feeders, which flow in deep narrow ravines 1000 to 3000 feet below its mean level.

The botany of Guge is scanty in the extreme; the country has been traversed by Moorcroft and Captain H. Strachey, and visited by Captain R. Strachey and Mr. Winterbottom, who collected fifty or sixty species of plants around the lakes, and calculated that not one-twentieth of its surface was covered with vegetation.

2. Piti and Parang.—Of these two valleys, that of the Piti river is entered from Kunawar by the Hangarang Pass, elevated 14,800 feet. The Parang Pass, over the range dividing the Parang from the Piti rivers, is 18,500 feet. The lofty platform of Rupchu, which extends from the Parang Pass across the main chain of the Himalaya to the adjacent head of the Zanskar valley, and from the Chumoreri lake to the Lachalang and Tunglung Passes, is elevated 15–16,000 feet; Chumoreri lake, situated on it, being 15,200. The vegetation of the whole province is extremely scanty.

3. Zanskar occupies the north slope of the main Himalayan chain, parallel with Kishtwar on the south. The change in the vegetation on crossing the Umasi Pass (18,000 feet) from Kishtwar is very sudden, only two or three species found at 12–13,000 feet on the Tibetan face being identifiable with

those of Kishtwar. Padum, the capital, is 12,000 feet above the sea; and a rich herbaceous vegetation occupies the river-flats and ravines. The Zanskar basin is cut off from that of the Indus by lofty ranges, and the defile through which the Zanskar river flows to the Indus is rocky and impracticable.

4. Dras.—This province occupies the same position relatively to Kashmir that Zanskar does to Kishtwar. The communication between Dras and Kashmir is by a remarkable depression—the Zoji Pass, whose elevation being only 11,300 feet, gives free access to the moist winds of Kashmir, and Dras is hence the most humid and fertile province of Tibet; its flora approaching very closely to that of Kashmir.

The openness of the valleys of Dras, and the occurrence of elevated plains or steppes at its north-west extremity, which have been called the plains of Deotsu, are remarkable exceptions to the generally rugged nature of Tibet; and the fact of Dras and Guge having both been visited and described by European travellers before most other parts of Tibet, and their both being so exceptionally level as compared with the rest of that country, has materially tended to spread the erroneous impression of the whole of Tibet being a series of elevated plains.

Artemisiæ and *Umbelliferæ*, including *Prangos pabularia*, are abundant in the Dras valley, and the prevalent *Chenopodiaceæ* of Tibet are scarce. *Vitis, Impatiens*, Black Currant, *Silene inflata, Aconitum, Hypericum, Vernonia, Juniperus, Thymus Serpyllum, Achillea Millefolia, Convallaria*, and *Tulipa*, all very rare in Tibet, occur in the valley. Towards the summit of the Pass, Dr. Thomson gathered 110 species on the Tibet side, of which all but six or seven were Kashmirian.

5. Nári.—Of this province (more accurately called Nari-Khorsum) nothing is known botanically; it is enormously lofty, utterly barren, and almost uninhabited, except on the lowest part of the ravine of the Indus, whose sources have not been visited by any traveller; nor has the province been

entered except by Moorcroft: it is wholly under Chinese influence.

6. Ladak.—This province, as restricted by us, extends from Nari to Balti, a distance of 230 miles, in which the Indus descends from 14,000 feet at Demchok, to 10,500 below Le, and at 8500 enters Balti.

From Hanle, the most elevated portion of this province, to its lower end, the increase of vegetation is very gradual along the valley of the Indus. The town of Hanle (14,300 feet above the level of the sea) is situated in a very open, undulating, barren, saline plain, six to eight miles in diameter, covered with bog-soil, and bearing plants characteristic of such localities. Bushes of *Myricaria* become common at 14,000 feet, and these attain the character of small trees at 13,000; below this, Poplars, *Hippophae, Rosa,* etc. commence, and form a low brushwood. Le, the capital of the province (and of West Tibet), is 11,800 feet above the sea.

7. Balti is a Mohamedan province, and extends from Ladak to the great bend of the Indus; it also includes the lower course of the Shayuk river, up to 10,000 feet. It is conterminous on the south with Dras and Hasora, and bounded on the north by the Kouenlun, or Mustagh. The axis of the latter is probably not less elevated than it is further east; but little is known of its slopes north of Balti, except that, owing to the damp winds finding free access by the Indus valley, they are more snowy than anywhere to the eastward.

The bed of the Indus at Tolti is elevated about 7500 feet; at Iskardo, the capital of the province, 7000; at Rondu, 6200; and at the great bend about 5000.

Throughout Balti the course of the Indus is in many places quite impracticable, from the narrowness of its defile and its rugged bounding mountains. Except in the presence of the subtropical genera mentioned at page 218, the vegetation of Balti presents little of interest. Vines abound, climbing over the poplars, and there is much cultivation in available situations.

8. NUBRA.—We have extended this province to the whole of the south flank of the Kouenlun, from Balti to Nari; it includes the districts of Nubra, Pangong, and Rodok, and is comprised within the basin of the Shayuk river and its affluents, including the Pangong lakes, which have now no exit, but which there is good evidence to prove once drained into the Shayuk river. This is the most lofty and sterile province of Tibet, except Nari; the axis of the Kouenlun being probably continuously upwards of 18,500 feet in elevation, and its main ramifications being equally lofty. The valleys enclosed between the latter extend for many miles at 16–17,000 feet, whilst numerous peaks in all parts rise 20–23,000. The elevation of the Karakoram Pass, on the axis, is 18,300; that of the Pangong lakes, which are very salt, 13,400 feet; and they are surrounded by mountains of 19,000 feet. The elevation of two of the passes over the range dividing the Indus from the Shayuk valley, north of Le, are 17,000 and 19,000 feet.

There is little peculiarity in the vegetation of Nubra; the plants of the lowest valleys are those of the Indus in Balti, *Populus Euphratica* being plentiful. *Ulmus pumila* occurs nowhere else in Tibet. Walnut and *Elæagnus* here find their northern limit, and are both scarce. In respect of cultivation, the Nubra valley is superior to any other part of Tibet of equal elevation, being comparatively well wooded, and the trees often affording shade, whilst green lanes blooming with *Clematis* and rue, and hedges of *Hippophae* enclosing fields of millet, wheat, buckwheat, and rape, are common around the villages. The only peculiar plants are a curious dwarf *Berberis* (*B. ulicina*, nob.) which grows at 14–15,000 feet, and a white-flowered *Allium* at 11,000 feet.

EASTERN TIBET is quite unknown to us botanically and geographically. The scanty notices published by the few travellers who have been able to penetrate into the interior of that strictly guarded country lead to the conclusion that it has the same general aspect as Western Tibet, as far east at all events as Jigatzi or Teshu Lumbu and Lhassa. The oral

information of the natives of the country confirms this. We learn from Turner that showers of rain are frequent about Jigatzi during the summer months; and as the winds in the valley of the Yaru are said to be generally east and south-east, the amount of rain-fall must increase as we descend that river, though, sheltered as it is by the Assam Himalaya and Mishmi mountains, the fall is no doubt comparatively insignificant.

Of the direction of the mountain-chain to the north of the Yaru nothing is known. The only Europeans who have visited it have been Captain Bogle in 1774, who resided at the monastery of Chammaning, in latitude 30½° north, when on a mission to the Supreme Pontiff; and, more latterly, Messrs. Huc and Gabet, who crossed it on their way from Kokonor to Lhassa. From the accounts of the latter travellers the country seems to be enormously elevated, and continuously so for a belt of many miles in breadth; and to this may be added the testimony of the Tibetans themselves, and the fact of so many of the greatest rivers of Asia rising within the same area.

Dr. Hooker collected a few plants on the southern border of Tibet to the north of Sikkim, and these, amounting to only fifteen or twenty species in two days' journey, are almost identical with those from equal elevations (16–18,000 feet) in West Tibet,—a stunted *Lonicera* and *Urtica* being the prevalent species at 16,000 feet, with creeping *Carices* in the sand, and tufted plants of *Alsineæ, Draba, Androsace, Oxytropis chiliophylla, Sedum, Saxifraga,* and grasses and sedges, most of which ascend to 18,000 feet. The curious genus *Thylacospermum* forms hard, hemispherical mounds on the stony soil at these elevations, and is one of the most conspicuous features of the flora. The ground was there everywhere covered with an efflorescence of carbonate of soda, and the pools of water were full of *Ranunculus aquatilis* and *Zannichellia palustris,* also typical of similar situations in West Tibet.

In the valley of the Yaru the Dama (*Caragana versicolor*) is said to grow, and to be the only firewood; and by the

streams, in sheltered valleys, are poplars, willows, and probably ash or walnut. Where the Aran enters Nipal, at Tingri, the vegetation appears (from a small collection we have received thence) to be similar to that of Kunawar.

At Lhassa the country is open and stony, and without trees, except such as are cultivated, just as in Western Tibet. Of these, the apricot is the only one of which we have any certain knowledge. Vines have been stated to grow in the city of Lhassa (Humboldt, 'Asie Centrale'), but this has been contradicted by all our informants. Further east, in the direction of China, we learn from Huc and Gabet's Travels that the mountains are covered with forests, while towards the south-east, in the valley of the Yaru, a subtropical climate is soon reached, tea, rice, and cotton being all cultivated.

III. *Eastern India.*

The axis, or watershed, of the great meridional chain which is continuous with the Kouenlun must be sought as far north as 35° N. lat., where it penetrates between the waters of the Hoangho and those of the Yang-tse-Kiang. It is, however, probable that the watershed of the Yaru river lies considerably further south than this chain, and occupies a position nearly parallel to that river, till it reaches 28° N. lat. in 98° E. long., after which its direction is nearly north and south, and it becomes the axis of the Malayan peninsula, which separates Ava and Siam on the one hand from Yunan and Cochin-China on the other.

To the north of this chain, in Tibet, lies a vast unknown tract, in which the head-waters of the Yang-tse-Kiang perhaps ramify, as well as those of the Tsa river, which is identified by Chinese geographers with the Neay-Kiang of Cochin-China. On the southern face of the chain the Dihong, the Brahmaputra, and the Irawadi, have their sources. It may therefore be considered to be the boundary of India in this direction, as the frontiers of Ava and China run nearly along it.

The chain of mountains which separates the waters of the Brahmaputra from those of the Irawadi, branches off from this main axis at an acute angle. Its direction is southwest, and it decreases rapidly in elevation after leaving the Mishmi country, forming the Naga hills, which extend from 96½° E. long. to the sources of the Cachar and Manipur rivers, and have an average height of 6000 or 7000 feet. Here the chain bifurcates, one branch running due west as far as the great bend of the Brahmaputra, while the other runs nearly due south. The western branch, under the name of the Cachar, Jaintia, Khasia, and Garrow hills, separates the valley of Assam from that of Silhet. Its elevation varies from 4000 to 7000 feet. The other, which separates Cachar, Chittagong, and Aracan, from Ava, has been called the Aeng range; it is less known, but is in many parts probably equally elevated.

The provinces of Eastern India selected for botanical divisions are—

1. Mishmi.
2. Assam.
3. Naga and Khasia.
4. Cachar and Silhet.
5. Chittagong and Tippera.
6. Aracan.
7. Ava and Pegu.
8. Tenasserim.
9. Malayan Peninsula.

1. Mishmi.

The country between India and China to the east of Assam is as little known as any other on the globe. Between the British frontier and that of China there are interposed a number of savage tribes, constantly at war, and so extremely jealous of one another that no offers of reward have been successful in inducing them to guide travellers into the interior of their mountains, though many efforts have been made since Assam was conquered by the Indian Government during the first Burmese war. At that time (as we learn from Captain Wilcox's very interesting narrative) a corps of scientific surveyors was attached to the army in the field, in order to be

ready to take every opportunity of improving our knowledge of geography. To the surveys of this corps, and in particular to Captain Wilcox himself, we are indebted for all that is known of these countries.

The Mishmi mountains, which occupy the most northerly part, are the southern and western slopes of a mass of snowy mountains which sweep round the north-west of Assam from the east bank of the Dihong to the sources of the Dihing river. The peaks of this chain are perhaps nowhere of great elevation as compared with the Himalaya, though many are covered with perpetual snow; and there are probably considerable depressions, as at the source of the true Brahmaputra, which is at the north-east angle of the chain, where the branch which runs west, and bounds Mishmi on the north, is given off. These mountains rise abruptly from the plain of Assam. They have been visited by Captain Wilcox and by Mr. Griffith, to whom we are indebted for all our information regarding their vegetation. The climate is extremely humid. The rainy season is the same as in Assam, but heavy winter rains occur, and the air is usually extremely damp.

The northern valleys of the Mishmi country appear to be included in Tibet, and from the accounts of the few travellers who have perilled their lives in attempting to ascend them, the Tibet frontier is gained in about fifteen days' march up the Brahmaputra, from the Kund or sacred pool of that river. Wilcox, indeed, approached the frontier village of Taling; and more recently a French missionary (M. Krick) reached the same spot, where he was forced to retire, owing to the jealousy of the authorities.

The flora corresponds very closely with that of Sikkim, Bhotan, and the Khasia mountains, and affords every indication of constant humidity. The mountains, up to six thousand feet, are covered with a dense tropical forest, in which *Calami*, *Wallichia*, *Areca*, *Caryota*, and *Arenga*, are common, with tree-ferns, *Pandanus*, and *Musa*. Oaks, chesnuts, a wild *Thea*, *Guttiferæ*, *Tiliaceæ*, *Verbenaceæ*, and *Araliaceæ* are cha-

racteristic trees. *Liquidambar* is also common, and parasitical *Orchideæ* and ferns are extremely abundant. A plant closely allied to *Rafflesia* (*Sapria Griffithii*), which was discovered in these mountains by Griffith, is the most remarkable form known to occur there.

The upper valley of the Brahmaputra is more open, and is richly cultivated, rice being the chief crop, and oranges the most abundant fruit-tree.

Higher up, the mountain-slopes are clad with pines of an undetermined species in great abundance. *Rhododendron arboreum* is also of frequent occurrence, and the temperate flora, so far as it is known, closely resembles that of Khasia.

The alpine flora is quite unknown; but we learn from Wilcox, who crossed a pass elevated 12,800 feet above the level of the sea*, on his journey to the Irawadi, that stunted Rhododendrons were common, and that a species of Juniper occurred on the crest of the pass, together with *Coptis Teeta*, a remarkable Ranunculaceous genus, which is not found in the Himalaya.

Though so luxuriant and tropical, the flora of the Mishmi hills below 6000 feet elevation did not yield Griffith a rich harvest,—he did not obtain a thousand species during his residence there. These consisted chiefly of tropical orders, amongst which the following are the most numerous in species:—

Compositæ	80	Rubiaceæ	42
Gramineæ	73	Acanthaceæ	38
Labiatæ	50	Leguminosæ	31
Orchideæ	43	Cyperaceæ	22

besides 200 Ferns.

These numbers are taken from his published journals; but, from our examination of the materials from which they were computed, they must be considerably reduced, especially the Ferns.

* Asiat. Res. xvii. 451.

2. Assam.

The province of Assam is bounded by the Himalaya and Mishmi mountains on the north, and by the Khasia and Naga hills on the south. It is a tropical valley continuous at its western extremity with the plains of Bengal, and gradually contracting to the eastward, till the mountains at last approach so close together that no level country remains between them. The width of the lower valley is about thirty miles; it is in general level, but low ranges of hills project occasionally from both sides almost to the Brahmaputra, and isolated hillocks occur scattered here and there over the surface.

The atmosphere is very humid, and dense fogs are frequent in winter. The rainy season lasts from May till October, and the rain-fall (about eighty inches at Gowahatti), though much less than on the mountains by which it is surrounded, is considerable. The climate is therefore on the whole equable, without excessive summer heat, and without great winter cold. Lower Assam is richly cultivated, but dense forest occupies the base of the hills on either side, as well as the hillocks which advance upon the plain.

In Upper Assam there is but little cultivation, and much forest, which is often almost impervious from rank underwood. Along the river the low alluvial plains, which at the junction of the Dihong are scarcely raised 350 feet above the level of the sea, are bare of trees, and covered with dense grass jungle. The mountains display a rich vegetation of the most tropical forms which India produces. *Anonaceæ* are numerous, several species of *Myristiceæ* occur, and the India-rubber fig forms large forests in some places. *Calami* and *Plectocomia* abound in the dense jungles, as well as other rare and interesting palms, belonging to the genera *Livistonia, Licuala, Arenga, Areca, Wallichia,* etc. Oaks and chesnuts are also characteristic types, as are *Guttiferæ, Ternstrœmiaceæ, Magnoliaceæ, Saurauja,* and tree-ferns.

The earliest explorer of the flora of Assam was Major Jenkins, who transmitted to Sir W. Hooker very extensive collections. Wallich, Griffith, and M'Clelland visited the valley in 1835, to investigate the then recently discovered tea forests, and Griffith returned to it more than once, so that its vegetation is now well known. Mrs. Mack and Mr. Simons have also enriched the Hookerian Herbarium with many interesting Assam plants. The *Ranunculus Chinensis*, a well marked Chinese species, occurs nowhere else in India; and Griffith has pointed out a multitude of instances of similarity between the floras of these two countries, in his able Report on the cultivation of the tea-plant in the Transactions of the Agricultural Society of Calcutta. The manufacture of tea has now been carried on for some years with considerable success in Upper Assam, but the wild tea (whose abundance in the forests of some parts led to the attempt in the first instance) is no longer used for that purpose. Griffith has given a general account of the botany of the Assam valley, in his Report on the tea cultivation already alluded to; as also in his "Remarks on a collection of plants made at Sadya, in Upper Assam," published in the Calcutta Asiatic Society's Journal, and in his private journals. He mentions having collected 1500 species, and computes that the whole flora must amount to at least 6000,—an estimate which, like all such made on similar data, is greatly exaggerated, and probably doubles the actual amount.

3. Naga and Khasia Hills.

The mountain range which bounds Assam on the south is known by a great diversity of names in different parts of its course, according to the different tribes by whom it is inhabited. The only part of the range which is well explored is that called the Khasia hills, across which a good road runs, by which a communication is kept up between Silhet and Gowahatti, the capital of Assam. These mountains have been explored botanically by Wallich and Griffith, and more recently by ourselves.

The Khasia hills rise abruptly on the south from the plains of Silhet to the height of about 4000 feet, and thence more gradually to 6000 feet. The culminating point is Chillong hill, the elevation of which is about 6600 feet. Their southern slopes are exposed to the full force of the monsoon, and the rain-fall is there excessive, amounting at Churra to 500 or 600 inches annually. Further in the interior the fall is less, and it gradually diminishes in amount till the valley of Assam is entered. On the north side the slope of the mountains is less abrupt, though there too there is a sudden fall from 5000 to 2000 feet, below which level a succession of gradually lowering hills continues to the Brahmaputra.

To the westward of the Khasia hills lie the Garrows, which are lower, the maximum elevation being probably nowhere more than three or four thousand feet. To the east, beyond Jyntea or Jaintia, which is similar in general character to Khasia, and will be included by us under that designation, there appears to be a considerable depression in the range, a large river with an open valley penetrating far to the north. These hills have, however, not been explored by Europeans. To the east of Cachar again there are lofty hills, inhabited by Nagas, and also quite unexplored, except in one place, where they were crossed by Griffith in travelling from Upper Assam to the Hukum valley, on a tributary of the Irawadi.

Notwithstanding the enormous rain-fall and the great humidity of the atmosphere, the higher parts of the Khasia hills are generally bare of trees, except in ravines and occasionally on northern exposures. This remarkable peculiarity is due partly to the nature of the surface, and the free drainage, but mainly to the removal of the soil by the heavy rains, and to the furious winds which sweep over the level tops of the hills. Wherever there is shelter, trees spring up at once; and the base of the mountains, and the deep valleys which penetrate far into the interior, are clothed with dense forest.

At the base of the Khasia the vegetation is tropical, and the plants the same as those of Assam. The sheltered and

well wooded dells possess a uniformly hot climate, and closely resemble similar spots on the Eastern Archipelago. *Vaccinia* are plentiful, and there are many representatives of the Malayan flora, such as *Myristica, Henslovia* (Wallich), *Polyosma, Cardiopteris, Antidesmæ, Apostasia, Cyrtosia,* and other Orchideæ, *Ternstrœmiaceæ, Sonerila, Medinilla, Erycibe, Cyrtoceras,* and *Tacca.*

Higher up, temperate climate forms become common, chiefly oaks (of which, including chesnuts, sixteen species are known), *Styrax, Magnolia, Garcinia, Sphærocarya,* and *Lauraceæ. Acanthaceæ* form a great part of the underwood, and balsams are very numerous. The open hill-sides are covered with a luxuriant herbage, remarkably rich in species; and at elevations above 5000 feet there is a remarkable predominance of northern forms, which are common on the Himalaya at greater elevations. Most of the large Himalayan genera are there represented. We find species of *Ranunculus, Anemone, Thalictrum, Delphinium, Corydalis, Geranium, Parnassia, Rubus, Potentilla, Sanguisorba, Astragalus, Saxifraga, Astilbe, Umbelliferæ, Valeriana, Senecio, Cirsium, Pedicularis, Primula, Tofieldia,* and *Iris.* Of many of the genera which abound in the temperate Himalaya there are only single species, of others there are several. *Rhododendron* is represented by several species. One of these, the common *R. arboreum,* has a very wide range in India: the others belong to the more eastern forms of the genus, and, like the species of Java, descend to very low elevations: of *Rosa* also, the only species is the Peninsular and Chinese *R. sempervirens.*

We have elsewhere (page 105) alluded to the prevalence of Chinese and Japan forms in Eastern India; many of these are Himalayan, but some are quite peculiar to the Khasia. Of these, *Pinus Sinensis, Nymphæa pygmæa, Aralia aculeata, Hamamelis Chinensis, Nepenthes phyllamphora,* and *Bowringia* of Hooker (a curious genus of ferns) are all Chinese species, which in India are almost confined to the Khasia. *Reevesia* and *Illicium* are genera confined, so far as is hitherto

known, to China and the Khasia; whilst *Helwingia, Microptelea, Corylopsis, Bucklandia,* and *Quercus serrata,* though all Chinese and Khasian, are also common to the Himalaya; and *Vaccinium bracteatum,* as we have elsewhere said, is found in China, the Khasia, and the Peninsula, but not in the Himalaya.

Podostemon is a remarkable genus, which is abundant in all the Khasian streams, even in the most rapid currents covering the stones in autumn with a bright green carpet. This genus is even more abundant in the Nilgiri and Ceylon streams, and also found in Mishmi, but is quite unknown in the Himalaya.

Palms are very abundant in the Khasia, though much less so than in the Malayan Peninsula and Eastern Archipelago. We collected twenty-five species, belonging to the genera *Phœnix, Licuala, Areca, Arenga, Plectocomia, Calamus, Caryota, Chamærops,* and *Wallichia.* Of these the *Chamærops* is probably identical with the Nipal and Kumaon *C. Martiana,* though not found in any intermediate part of the Himalaya. *Livistona,* which is said to occur at the northern base of the Khasia, is found no further west.

There is only one pine in the Khasia mountains, *Pinus Sinensis.* This species is not known as a native of the Himalaya, but it is not impossible that it may occur in some parts of Bhotan. It may be conjectured too that it also extends into the mountains of the eastward, but we do not yet know any details of its distribution. In the Khasia hills it is not found in the very rainy southern districts, but becomes common in the valley of the Boga Pani below Moflong, and thence extends throughout the range, and descends towards Assam. The absence of *Pinus longifolia* is curious, as there is nothing in the climate adverse to its growth; but the elevation is not sufficient to lead us to expect the occurrence of any other of the Himalayan pines, or of the subalpine plants which accompany them. The common yew is however found at 5–6000 feet, and two species of *Podocarpus* occur on the

lower hills, together with *Cycas pectinata* and *Gnetum scandens,* which are abundant everywhere.

As in all very humid climates, orchids occur in very great abundance in the Khasia mountains, constituting there at least one-twelfth of the vegetation, and being by far the largest natural order of flowering plants! They are equally abundant at all elevations. Many are epiphytes, but terrestrial species are also common, both in dense woods and in open grassy places. *Scitamineæ* are very numerous. From the barrenness of the surface over a great part of the hills, grasses constitute the most prominent feature in the flora of this district, occurring gregariously in prodigious abundance. Most of the species belong to the tropical division of the order, coarse *Paniceæ* being the prevailing forms, but there are also many *Poaceæ* of European genera.

In some respects the vegetation of the Khasia approaches more closely in its features to that of the mountains of the Peninsula than of the Himalaya: this arises mainly from the form of the hills and their much less rugged outline, their valleys being more open, though with steeper flanks, and the hill-tops broader. Hence the grassy slopes being covered with clumps of shrubby vegetation, and the forest being confined to sheltered localities, are remarkable features in common with the Nilghiri, but quite foreign to the Himalaya; to which must be added a very strong resemblance in the genera and species forming the mass of the shrubby vegetation, which, though almost all Himalayan, are there less gregarious and more interspersed with large trees of different genera. These consist of:—

Rhododendron *arboreum.*	Styrax.
Pieris *ovalifolia.*	Callicarpa, several species.
Ligustrum.	Celastrus, ditto.
Eurya, two species.	Michelia, ditto.
Vaccinium *bracteatum.*	Goughia *Himalaica.*
Gaultheria, several species.	Gomphandra.
Symplocos, ditto.	Photinia, several species.

Ilex.	Berberis.
Eugenia.	Casearia.
Myrsine.	Cleyera.
Laurineæ, various genera.	Viburnum, several species.
Rubiaceæ, ditto.	Elæocarpus.
Compositæ, ditto.	Elæagnus.
Jasminum, ditto.	Turpinia.
Indigofera.	Araliaceæ, several species.
Saurauja, several.	

To these must be added certain Himalayan temperate genera that are Khasian, but not Peninsular, especially oaks and chesnuts :—

Holböllia.	Cerasus.	Microptelea.
Manglietia.	Prinsepia.	Carpinus.
Magnolia.	Benthamia.	Helicia.
Talauma.	Leycesteria.	Betula.
Spiræa.	Itea.	Sabia.
Pyrus.	Hydrangea.	Sphærostema.
Corylopsis.	Adamia.	Taxus.
Bucklandia.	Luculia.	Pinus.
Neillia.	Hymenopogon.	Camphora.
Pomaceæ, several.	Limonia.	Chamærops.
Camellia.	Wightia.	Plectocomia.
Acer.		

And of herbaceous forms :—

Codonopsis.	Saxifraga.	Pyrola.
Corydalis.	Sanguisorba.	Monotropa.
Dicentra.	Lychnis.	Veronica.
Panax *Pseudo-ginseng*.	Anisadenia.	Dipsacus.
	Circæa.	Iris.
Delphinium.	Sarcopyramis.	Allium.
Astragalus.	Crawfurdia.	Paris.
Astilbe.	Primula.	Polygonatum.

Of Khasian temperate forms common also to the Peninsula, but not found in the Himalaya, *Vaccinium bracteatum,* also a native of China, is almost the only example.

During our five months' residence in the Khasia we collected 2264 species of flowering-plants and nearly 200 ferns. The following natural orders are noticeable for the number of species they contain:—

Ranunculaceæ	13	Verbenaceæ	29
Menispermeæ	15	Scrophularineæ	40
Magnoliaceæ	9	Labiatæ	57
Vitaceæ	34	Cyrtandraceæ	24
Balsamineæ	22	Acanthaceæ	58
Ternstrœmiaceæ	14	Asclepiadeæ	45
Aurantiaceæ	18	Polygoneæ	26
Malvaceæ, Byttneriaceæ, Sterculiaceæ, Tiliaceæ	37	Amentaceæ	20
		Laurineæ	24
		Urticeæ	82
		Euphorbiaceæ	58
Leguminosæ	123	Gramineæ:	
Rosaceæ	37	Paniceæ	122
Melastomaceæ	17	Poaceæ	42
Myrtaceæ	14	Cyperaceæ	91
Cucurbitaceæ	31	Scitamineæ	37
Umbelliferæ	19	Commelyneæ	18
Araliaceæ	30	Aroideæ, Orontiaceæ	29
Rubiaceæ	112		
Compositæ	87	Palmeæ	25
Myrsineæ	36	Orchideæ	173
Convolvulaceæ	26		

The Naga hills, to the eastward, probably exhibit a very similar vegetation to the Khasia, as their elevation is about the same. They were crossed by Griffith in the month of March, at which season vegetation at considerable elevations is nearly dormant. The greatest height attained by him was 5600 feet. He describes these hills as much more covered with forest than the Khasia,* and states that the southern slopes are moister than those to the north. As the rain-fall must be much less than it is on the southern slope of the Khasia, the greater amount of forest is probably caused by the diminished vio-

* Private Journals, p. 120.

lence of the winds, which in the Khasia sweep with tremendous force over the nearly level hill-tops.

The flora of the Naga hills is only known by the few notes published in Griffith's journals, as the collections which he made there have not been distributed. Except *Liquidambar* and *Kaulfussia Assamica*, Griffith notes no plants as differing from those of the Khasia; the general forms are therefore certainly the same. He especially alludes to the absence of *Coniferæ*, of which however a species is said to abound on the hills of Manipur, to the southward. Of genera indicating elevation, he mentions *Acer, Vaccinia, Daphne, Berberis, Bucklandia, Crawfurdia, Viburnum,* and *Cyathea,* all equally typical of elevation in the Khasia and Eastern Himalaya. At lower levels, Oaks, *Gordonia, Camellia, Mesua, Bucklandia, Magnolia, Æsculus, Pandanus, Areca, Caryota,* and tree-ferns, are indicated as prevalent forms.

4. Cachar and Silhet.

The valley, or rather marshy plain of the river Súrma, which lies to the south of the Khasia mountains, very much resembles the Assam valley in its general features. It is an open plain, scarcely raised above the level of the sea, which is three hundred miles distant, and presenting here and there a few scattered hills: below, it expands into the Jheels of Eastern Bengal, and contracts in its upper part, as the spurs of the Tippera and Naga hills encroach upon it, separating fertile plains by narrow ridges covered with dense forest. The mountains which skirt this plain on the north nowhere attain an elevation of more than 7000 feet, and those on the south are very low and everywhere covered with dense forest. The climate is the same as that of Bengal and Assam, but more healthy; the rains are heavy, the winter more mild, and the spring moist and not hot. The rain-fall at Silhet is very great, more than 200 inches having been registered in one year. At Cachar it is equally heavy.

The vegetation of the open plains of Silhet is the same as

that of Bengal, and on the wooded hills we find a flora closely resembling that of Assam. In the moister forest, *Anonaceæ* are extremely numerous, and species of *Calamus*, tree-fern, and *Pandanus* are equally so. Oaks occur in the forests down to the level of the river Súrma, with *Camellia, Kadsura, Sabia, Rubus*, and other plants usually considered as indicating a certain degree of elevation.

The low hills which rise out of the plain in the neighbourhood of Silhet, and in several other parts of the district, are covered with brushwood, amongst which are many remarkable plants, as *Licuala peltata, Adelia castanocarpa, Trophis, Connarus, Grewia, Briedelia, Gelonium, Moacurra, Mussænda, Guettarda*. There are also some shrubs which here find their northern limit, but which are common in similar localities in Chittagong: as instances, we may mention *Dalhousiea* and *Linostoma*. In the grassy sward which covers the swampy plains interspersed among these hills, we find also *Stylidium Kunthii*, a minute annual, which is interesting as the most northerly species of the eminently Australian order to which it belongs.

Many plants from this district were communicated to Roxburgh by Mr. Smith, Judge of Silhet, Mr. Dick, and other residents, and by the Garden collectors; and are published in his 'Flora Indica.' Dr. Wallich's collectors were long at Silhet, and sent him large collections; and the authors of the present work, in the autumn of 1850, ascended the Súrma from Silhet to Silchar, and collected several hundred species.

The Jheels of Eastern Bengal are in many respects a most remarkable feature, and as they owe their origin chiefly to the excessive rain-fall of the Khasia and Silhet, and to the overflow of the Súrma, we have noticed them under this province, in preference to Bengal, in which they would otherwise have been included.

The Jheels occupy an immense area, fully 200 miles in diameter, from north-east to south-west, which is almost entirely under water throughout the rainy reason, and only par-

tially dry in the winter months. They extend from the very base of the Khasia and eastern extremity of the Cachar district, southward to the Tippera hills and Sunderbunds, and westward to the Megna and considerably beyond it, thus forming a freshwater continuation of the Sunderbunds, and affording a free water-communication in every direction. The villages, and occasionally large towns, which are scattered over the surface of the Jheels, generally occupy the banks of the principal rivers; these have defined courses in the dry season, their banks always being several feet higher than the mean level of the inundated country.

Extensive sand-banks, covered in winter with a short sward of creeping grasses and annual weeds, run along the banks of the largest streams, and shift their position with every flood. The remainder of the surface is occupied by grassy marshes covered in winter with rice crops, and in summer with water, upon which immense floating islands of matted grasses and sedges are seen in every direction, gradually carried towards the sea by an almost imperceptible current. The principal floating grasses are *Oplismenus stagninus* and *Pharus aristatus*, which together form the mass of each islet; and along with these occur *Azolla, Salvinia, Utricularia, Villarsia* of two species, *Jussieua, Trapa, Pistia,* and several aquatic *Scrophularineæ*.

In shallower water, *Vallisneria, Hydrilla, Potamogeton, Damasonium,* several *Nymphææ, Myriophylla,* and *Ceratopteres* carpet the bottom, whilst *Confervæ* and the many tribes of fresh-water Algæ, so common in temperate latitudes, are comparatively rare.

In the marshes the principal grasses are *Panica, Paspala,* and their allies, with tall *Andropogons, Sacchara, Erianthus, Arundo, Apluda,* and *Rottbœllia* in the greatest abundance. Mixed with these are *Typha, Scleria* and numerous *Cyperi,* but no large *Junci.*

On the banks of the principal streams a fringe of brushwood consists of *Stravadium, Tetranthera, Grewia,* various

Rubiaceæ, Eugenia, Gouania, and with occasionally immense quantities of *Alpinia,* more rarely *Rosa involucrata, Calamus Rotang,* and in sandy places *Tamarix.*

Convolvuli, a few *Asclepiadeæ, Cucurbitaceæ,* and all the weeds of Bengal, abound in favourable situations; and by the villages a few scattered figs, clumps of bamboo, mango, and *Areca,* are all seen, though rarely.

5. Tippera and Chittagong.

The valley of the Súrma is separated from that of Manipur by a meridional range of moderate elevation, which is continued to the southward, and separates Tippera, Chittagong, and Aracan from the kingdom of Ava. The nature and elevation of the axis of this range are unknown, but its ramifications extend to the sea-coast, and are separated by cultivated valleys, the direction of which is in general southwesterly or nearly due south. These ranges appear to increase in elevation as we proceed southward, but our knowledge of them is very imperfect. Blue Mountain, which lies nearly due west of Chittagong, is said to attain the considerable elevation of 8000 feet, and a peak on the same range forty miles to the south-west, in lat. 22°, is elevated (according to Wilcox's map) 3100 feet. Sitakund, thirty miles north of Chittagong, has an elevation of 1140 feet.

The provinces of Tippera and Chittagong are throughout hilly. Along the sea-coast there is in general a narrow belt of level ground, and the basins of the rivers are usually wide and well cultivated for a considerable distance inland. In the upper part of their course, however, they are hemmed in by hills, and a broad belt of impenetrable forest occupies the interior, and forms an impassable boundary between the British territories and those of Ava. The climate is similar to that of Bengal. From the proximity of the sea and the situation within the tropic, the winter is very mild, and the atmosphere always humid. The rain-fall during the monsoon is about the same as in Bengal, at least on the sea-coast and in its imme-

diate vicinity, averaging 86 inches annually at Chittagong; on the higher ranges in the interior it is probably much more considerable. The low hills of Tippera, immediately to the south of the Súrma valley, are said to be covered to a great extent with dry bamboo jungle, extending uninterruptedly for miles and being almost uninhabited. The southern slopes may be expected to be more humid, as they are fully exposed to the rainy wind.

The vegetation of Chittagong is very similar to that of Silhet. The higher hills are covered with dense but often dry forest, and the lower ones with brushwood. Oaks (which grow down to the level of the sea), two species of nutmeg, *Dillenia pentagyna, Butea, Pongamia, Mesua, Gordonia, Engelhardtia, Henslovia,* and several *Dipterocarpi*, are conspicuous in the forests. Of the latter, *Dipterocarpus turbinatus*, which yields the well known and valuable Gurjun, or wood oil, is extremely abundant, towering over the other forest-trees. *Cycas* is common. On the drier hills we have the same shrubs which have already been enumerated as growing in similar situations in Silhet, with *Linostoma* in very great abundance, *Pterospermum, Dalhousiea, Bradleia, Melastoma, Litsæa, Tetranthera, Scepa, Calamus fascicularis, Wikstræmia, Ixora, Adelia, Moacurra, Cæsalpinia, Mussænda, Guettarda, Gelonium, Jasminum, Memecylon,* and *Congea;* and of small trees, *Ægle Marmelos, Amoora, Gaurea,* Figs, and *Micromelon.* In damp woods are many *Calami,* two *Wallichiæ,* three *Arecæ,* various *Lagerstræmiæ, Meliaceæ,* many *Leguminosæ, Terebinthaceæ, Verbenaceæ,* and *Magnoliaceæ,* all growing in great luxuriance, and most of them forming gigantic forest-trees.

In consequence of the great influx of fresh water which is discharged into the Bay of Bengal by the Megna and Fenny rivers, the eastern part of that sea remains almost fresh for a very considerable distance from the shore. Even at the mouth of the Chittagong river the water is only brackish, and the maritime tropical vegetation of mangroves, and such plants, does not commence till we advance as far south as Ramri

island. At the same place we find the northern limit of *Casuarina equisetifolia*, the most northerly species of the family of *Casuarineæ*, which is chiefly confined to Australia. The Indian species is extensively cultivated throughout Bengal. On the low islands along the coast the vegetation is very scanty, and chiefly consists of creeping grasses, with *Dilivaria*, *Excœcaria*, *Tamarix*, *Rhizophoreæ*, *Acrostichum aureum*, and a Composite shrub.

Our knowledge of the flora of these provinces is chiefly derived from Roxburgh's 'Flora Indica;' many of the most interesting species published there having been communicated to him from Tippera and Chittagong. Our own small collection, which was made in the months of December and January, amounts to about 600 species.

6. Arracan.

The province of Arracan is a narrow belt of land, 290 miles long, hemmed in between the sea and the Aeng or Youmadang range of mountains, which lies very near the coast. It is traversed from north to south by a large river, navigable for a considerable distance into the interior; and by numerous smaller rivers, all of which have tidal channels, and form a sort of delta along the coast, which is skirted by many islands. From the proximity of the mountains to the coast, and their considerable elevation, the rain-fall is very great, amounting to 160 and 180 inches annually.

The botany of Arracan is quite unknown, and the climate of the interior is very unhealthy. Along the sea-coast are forests of mangroves, and there is in all the valleys very extensive rice cultivation, the plains being inundated during the monsoon. Tobacco of superior quality is also cultivated. The mountains may be expected to produce the same plants as are found in the Malayan peninsula, to which the climate approximates very closely; they are clothed with heavy forests and bamboo jungle. The gamboge is said to be found in the

island of Cheduba, and if so, the latter is the northern limit of that tree.

7. Ava and Pegu.

The sources of the river Irawadi are, according to the best authorities, between 27° and 28° of north latitude, and the direction of its valley is nearly due north and south. The mountains in which this immense river takes its rise probably rival in height the Eastern Himalaya, but the meridional ranges which bound its valley on each side do not long retain any great elevation, though they are continuously from 4000 to 8000 feet in height almost as far as the sea. The transverse range, which separates the upper part of the western branch of the Irawadi from the valley of Assam, is also of moderate elevation, varying probably between 5000 and 6000 feet.

The slope of the valley of the Irawadi is greater than that of the Indus or Ganges, if the estimates of elevation given by Griffith may be relied on. The valley of Hukum is stated to be 1000 feet above the level of the sea. The determination however was made by boiling water, which, at such low levels, is too fallacious a test to be depended on. The central branch of the Irawadi, at Manchi in 27° 20′ north latitude, where it was visited by Wilcox, has an elevation of 1800 feet*, and runs over a pebbly bed. Its elevation at Bhaumo, in lat. 24°, is estimated by the same authority to be about 500 feet. The valley of the Irawadi is much less open than that of the Ganges, being interrupted in many places by transverse ranges. In the upper part of its course these are numerous, and the lateral valleys they enclose are comparatively small; but lower down there is a great expanse of level country, though the hills occasionally attain an elevation of 3000 or 4000 feet close to the river.

The direction of the monsoon wind in the valley of the Irawadi appears to be nearly from south to north. The

* As. Res. xvii. 441.

mountains to the north-east are considerably more elevated than those to the northward, over which the aerial current probably flows into the valley of Assam.

The first condensation of the moisture-laden winds takes place in the lower part of the valley, which is hemmed in by hills at the apex of its delta. Further north there are no more considerable elevations till we reach the sources of the Irawadi, so that in the central part of its course the rain-fall is comparatively small. We have therefore in Pegu a climate like that of the Gangetic delta, the rain-fall amounting at Rangoon to 85 inches; but in Ava a dry climate, like that of the Gangetic valley, or the Carnatic, prevails, with a moderate rain-fall at one season only. The upper valley is again more humid, from the loftier mountains and the more irregular surface of the country.

In the delta of the Irawadi there is a maritime vegetation of mangroves, *Sonneratia, Heritiera, Excœcaria,* and other saline plants, just as in similar salt-marshes along the coasts of the tropics. Throughout the plains of Pegu the vegetation is like that of the Gangetic delta, or the open parts of the valley of Assam. Cocoa-nut, *Corypha,* and *Borassus* are the common palms, with *Pandanus, Stravadium,* and abundance of epiphytical *Orchideæ.* On the mountains the flora is of course more varied, and is a continuation of that of Tenasserim to the south.

In Ava, with a climate and temperature very similar to that of the Carnatic, we find an almost identical vegetation. *Capparideæ* are common, with acacias, an arboreous *Euphorbia, Calotropis gigantea, Guilandina Bonduc, Zizyphus,* and *Bombax;* mangos and *Fici,* with *Borassus,* are cultivated. Teak is common on the mountains. The vegetation of the higher parts of the Irawadi is described by Griffith as very similar to that of Assam.

The valley of Manipur is drained by the most westerly tributary of the Irawadi: it is separated from Cachar by a mountain range, which is 6000 or 8000 feet high, and is

pine-clad towards the summit. The valley of Hukum (or Hookhoom), which was visited by Griffith, is more open, but is surrounded on the north and east by mountains elevated 5000 and 6000 feet, and is traversed by numerous ranges of low hills.

We do not know the boundaries between the different provinces on the Irawadi, nor is it necessary for our purpose to distinguish them, as the upper country is unknown to us.

Dr. Wallich, who accompanied Mr. Crawfurd's mission to Ava soon after the close of the Burmese war in 1826, was the first botanist who explored the vegetation of the Irawadi. He ascended that river as far as the capital, and visited the mountain range bounding the Taong-dong river to the eastward, from which some of his finest plants were obtained. Mr. Griffith, in 1837, entered Ava from Assam, and descended the Irawadi to its mouth, but the collections made by him on this journey have not been distributed. Since the earlier sheets of this Introduction were printed, Dr. M'Clelland has forwarded to the Hookerian Herbarium an excellent and very valuable collection from Pegu.

8. Tenasserim.

The province of Tenasserim is separated from Pegu by the Sitang river, and extends south to the commencement of the Malayan Peninsula, including the districts of Martaban, Tavoy, and Tenasserim. At its northern extremity, the great river of Martaban forms an extensive alluvial plain like that of Pegu, bounded to the east by mountains of considerable but unknown elevation. Elsewhere the mountains approach the coast, and are said to attain occasionally, but not continuously, an elevation of 4000 or 5000 feet. The coast is generally alluvial; tidal channels, which separate a broad and continuous belt of islands from the main, run into the interior, and the hilly tracts are covered with dense forest.

In climate Tenasserim is intermediate between Arracan and the Malayan Peninsula. The summer rains are every-

where heavy and long continued, commencing in May or the beginning of June, and lasting till November, and amounting at Tavoy to 208 inches, and at Maulmain to 175. In the more northern parts the winter is dry, the north-east wind being deprived of its moisture by high ranges of mountains. South of Tavoy the winters are more humid, and rain is of frequent occurrence at all seasons.

The vegetation of Tenasserim is a continuation of that flora which, commencing in Sikkim and Bhotan, is continued throughout the Malayan Archipelago. Oaks and *Dipterocarpi* are very common; and a pine, probably *P. Sinensis*, grows on the mountains north of Martaban. *Calami, Zalacca*, and other tropical palms, are abundant in humid jungles, and enormous bamboos in more open places. Teak is common in the interior, but has its southern limit in 15° N. lat., where the winters become too humid for its growth. The *Amherstia nobilis*, one of the most remarkable and local trees in the province, has hitherto been found only on the banks of the Salueen river; *Barclaya longifolia*, a remarkable genus of water-lilies, is confined to this province and the adjacent one of Pegu; and the *Melanorrhœa usitatissima*, or black varnish tree, abounds in many parts.

Dr. Falconer, in his able report on the teak forests of Tenasserim, gives some valuable remarks on the vegetation of the province, and the following list of prevalent timber-trees:—

Dillenia.	Elæocarpus.	Melanorrhœa.
Uvaria.	Aglaia.	Blackwellia.
Guatteria.	Heynea.	Toddalia.
Myristica.	Dipterocarpus.	Turpinia.
Cratæva.	Hopea.	Inga.
Bombax.	Vatica.	Acacia.
Sterculia.	Gordonia.	Pterocarpus.
Paritium.	Calophyllum.	Butea.
Grewia.	Garcinia.	Dalbergia.
Pterospermum.	Millingtonia.	Pongamia.

Cathartocarpus.	Diospyros.	Gynocardia.
Cassia.	Bignonia.	Trewia.
Conocarpus.	Calosanthes.	Quercus.
Lagerstrœmia.	Spathodea.	Castanea.
Jambosa.	Tetranthera.	Antidesma.
Careya.	Croton.	Ficus.
Nauclea.	Rottlera.	Artocarpus.

Martaban was visited in 1827 by Wallich, and more recently by Falconer. Mergui and Maulmain have been explored by Griffith, whose extensive collections have been distributed; and by Mr. Lobb, who has communicated some interesting plants to the Hookerian Herbarium.

9. Malayan Peninsula.

The Malayan peninsula extends from the southern extremity of Tenasserim, almost to the equator, the island of Singapur being in 1½° N. lat. Its width varies from 150 to 100 miles, and near the southern extremity it contracts to about fifty miles. A low range of hills traverses the whole length of the peninsula, rising occasionally into isolated peaks, of which the highest, Mount Ophir, near Malacca, attains 4320 feet*, but they are usually very much lower. The island of Penang is 2922 feet high.

On either side of the central axis, low ranges of hills descend towards the sea, so as to give an undulating outline to the surface. These are separated by swampy flats of considerable length, which are narrow and often under water, but there are no plains of any extent. The coast is occasionally rocky or skirted by coral reefs, at other places low and muddy. The direction of the rivers is generally at right angles to the axis. Their banks are for the most part muddy and low, and

* This height is taken from a paper by Logan, in the 'Journal of the Malayan Archipelago' (ii. 137). According to the same authority, Kedah peak is 3897 feet high. Mr. Logan informs us that the elevations given by Newbold for these peaks (5693 and 5705 feet) are mere guesses.

those of larger size are navigable for small vessels to a considerable distance.

The northern part of the peninsula is now subject to the kingdom of Siam, which has extended its limits to the south, so as to occupy the state of Kedah. Further south, independent Malays possess the whole of the country, except the three British settlements of Penang, Malacca, and Singapur.

From its proximity to the equator, and from the peculiarity of its shape,—a long, narrow strip of land, nearly enclosed by sea,—the Malayan Peninsula enjoys a very mild and equable climate. The monsoon winds, which are influenced by general causes at a great distance, prevail here with as much regularity as elsewhere in India, the south-west monsoon continuing while the sun is north of the equator, and the north-east monsoon from October to March, while the sun is in the southern hemisphere. Local causes, however, modify these winds very much, and regular land and sea breezes blow along the coast. Both these monsoons are rainy, as they traverse a great extent of sea, and the mountain ranges everywhere condense the vapours. The north-east monsoon is, however, more rainy than the other, because the mountains of Sumatra, which receive the first supply of moisture from the south-west monsoon, are considerably more elevated than those of the peninsula itself. The most rainy months are, therefore, from November to January, and February is the coldest month of the year. In the Straits of Malacca the rain-fall is nowhere excessive. On the hill of Penang it was in one year 116·6 inches, and on the plain at its base only 65·5 inches, while in the province of Wellesley, on the opposite coast, the amount was 79·15 inches. At Singapur the fall is 98 inches, and at Malacca the same. On the south coast of Sumatra, and on the north-eastern face of the Peninsula, the fall is probably much greater. The mean temperature of Singapur is 79·7°, and the temperature of the different months differs very little from the mean of the year.

In the equable and humid climate of Malaya, we have a

vegetation almost identical with that of Java. The surface, except where clearances have been made by man, is covered with a shady forest, rendered almost impenetrable by a dense jungle of rattan (*Calamus*), a genus which attains its maximum development in the Malayan region. Erect palms are also very numerous; chiefly of the genera *Areca, Arenga, Licuala, Cocos, Corypha,* and *Sagus*. On the coast, *Nipa* covers immense tracts. Orchids, terrestrial as well as epiphytical, *Scitamineæ, Araceæ,* and ferns, abound in the forests, which consist chiefly of gigantic *Terebinthaceæ, Sapindaceæ, Meliaceæ, Garciniaceæ, Dipterocarpeæ, Ternstrœmiaceæ, Leguminosæ, Myrtaceæ, Combretaceæ, Lauraceæ,* oaks, and figs. *Dilleniaceæ,* nutmegs, *Sapotaceæ,* including *Isonandra Gutta* (the gutta-percha plant), and *Anonaceæ,* form an unusually large proportion of the flora. *Podocarpus, Dacrydium,* and *Dammara* are the only conifers, but there are several species of *Gnetum* and of *Cycas*. On the higher hills a few species of *Gaultheria, Rhododendron, Vaccinia,* and other plants of the sub-temperate zone, indicate the commencement of that rich and varied flora which covers the middle and upper parts of the mountains of Java and the Khasia, and is also found in the temperate Sikkim Himalaya.

Amongst the many rare and curious genera which occur in the forests of the Malayan Peninsula, may be mentioned *Grammatophyllum,* the most gigantic Orchid known, *Kibara,* many *Nepenthes,* several curious genera of *Aristolochiæ,* as *Thottia, Lobbia,* and *Asiphonia,* anomalous *Burmanniæ,* many *Antidesmeæ,* including *Eremostachys* and *Phytocreneæ,* as *Iodes, Cardiopteris,* and *Phytocrene* itself, many singular *Olacineæ, Santalaceæ, Loranthaceæ, Menispermeæ,* etc. The cultivated fruits are the mangosteen, durian, and nutmeg, none of which thrive elsewhere in India; with many varieties of *Citrus* and pine-apple. The littoral plants are to a great extent the same as those of Pegu and the Sunderbunds, but there are more species of mangrove and of palms. *Enhalus* and other oceanic *Caulinia* occur beneath high-water mark. The ap-

pearance of Australian forms in the Malay Peninsula has been alluded to at p. 103, and is shown by species of ***Stylidium***, ***Bæckia***, ***Melaleuca***, ***Casuarina***, ***Leptospermum***, ***Leucopogon***, ***Tristania***, and ***Dacrydium***. It is a remarkable fact that the teak, which abounds in some parts of Java and in the northern districts of Tenasserim, is not known to inhabit the Malayan Peninsula.

Jack was the first botanist who explored the Malayan Peninsula. Some years later, Dr. Wallich visited Penang and Singapur, where he made large collections: a part of Mr. Cuming's collection was also formed in Malaya. More recently, Griffith was for a considerable period resident at Malacca; and it is from his notes and collections that our detailed knowledge of its flora is derived. Sir W. Norris, Mr. Prince, and Dr. Oxley have also added much to our information.

IV. *Afghanistan and Beluchistan.*

The great chain of the Kouenlun, which separates the Indus and its tributaries from the Yarkand plain, is continued to the westward, under the name of the Hindu Kúsh. This chain, which has a westerly direction, with some southing, separates the basin of the Oxus on the north from that of the Kabul river, a tributary of the Indus, and from the Helmand, a river which runs towards the south-west, and is lost in the desert of Sehistan, not reaching the sea. The elevation of the chain diminishes rapidly to the westward, but few accurate determinations of its height are known. The Kalu pass, near Bamian, is 12,500 feet, and the peak of Koh-i-Baba, which rises close to it, is 17,000 feet above the level of the sea. The Erak (or Irak) pass is 12,900 feet.

From the neighbourhood of the peak of Koh-i-Baba a meridional chain runs nearly due south to the Indian Ocean, forming the watershed between the Indus on the east and the Helmand on the west. The axis of this chain passes close to Ghazni, elevated 7726 feet; and to Quetta, 5540 feet. It

lies probably to the westward of Kelat, but our maps are not sufficiently accurate to make its course in that direction obvious. At its point of origin this chain is more than 13,000 feet in height; where it is called the Saféd-Koh, or White mountains, it is 14,000. Near Ghazni it is from 9000 to 10,000 feet high; and near Quetta its elevation is nearly as great, for the peak of Chahil Tan rises to 10,500 feet. Its eastern ramifications are high ridges which dip abruptly into the valley of the Indus; one peak, near Dera Ismael Khan (called Takht-i-Suliman), attains a height of 11,000 feet, and the range south of the Kabul river rises still higher. The deceptive appearance of a chain of mountains running parallel to and near the west bank of the Indus is given by the extremities of the eastern spurs of these ridges, and has no existence except upon our maps. To the westward, long ranges of rugged mountains branch from it, and stretch far in a south-west direction before they sink into the elevated table-land of Persia. The elevation of Candahar is 3480 feet, and that of Bamian 8500.

Excepting in the most eastern part of Hindu Kúsh, between the Kuner and the Gilgit rivers, these mountains nowhere rise to the height of perpetual snow, except on the peak of Koh-i-Baba. Their outline is often rounded; they are in general bare and stony, separated by wide elevated valleys, 1000 or 2000 feet below the ridges. Water being scarce, the valleys are sterile and very rocky.

Throughout Afghanistan the climate is excessive. The cold of the winter is intense, the spring is damp and raw, and the summer, during which hot west winds prevail, is intensely hot at all elevations. Winter and spring are the rainy (or snowy) seasons, while the summer and autumn are dry. The return upper current of moist air, which passes northward during the prevalence of the north-east monsoon, is condensed by the mountains, and heavy falls of snow are of frequent occurrence during winter at all elevations above 5000 feet, or a little lower in the immediate vicinity of the Hindu Kúsh. In

the low valleys heavy rain falls at this season. Spring sets in in March in the temperate zone, and with the change of the monsoon (about the equinox or a little later) heavy rains occur, caused perhaps by the southerly direction of the monsoon wind, before the Indo-Gangetic plain becomes intensely heated, and deflects that wind into a westerly current.

The general aspect of the whole of Afghanistan is that of a desert. As the mountains rarely rise to the region of perpetual snow, water is very scarce after the termination of the spring rains; but when the country was the seat of a great empire, an energetic race of inhabitants conducted every available streamlet into artificial channels, by the help of which an extensive cultivation is still carried on in many of the valleys. Around the chief towns and many of the villages, therefore, the country is beautifully verdant. The crops are chiefly wheat and barley, even up to 10,000 feet elevation. Rice is cultivated in great quantity at Jellalabad (2000 feet), at Kabul (6400 feet), and to a considerable extent at Ghazni (7730 feet). Poplars, willows, and date-palm trees are extensively planted, as well as mulberry, walnut, apricot, apple, pear, and peach-trees, and the *Elæagnus orientalis*, which also bears an eatable fruit. The vine abounds, as in all warm and dry temperate climates.

The flora of Afghanistan is an extension of the Arabian and Persian, with a few Himalayan types. From the great solar power, and the absence of rain during summer, the heat is excessive, so that the vegetation is that of a hot, dry country. On the southern slopes of the Hindu Kúsh the great elevation of the chain produces more humidity than elsewhere in Afghanistan; and there is therefore a forest belt, which extends from 5000 to 10,000 feet. These forests are entirely confined to the mountains which rise out of the valley of Jellalabad, and do not extend further west than the 69th degree of longitude: elsewhere the country is extremely barren, and almost destitute of tree vegetation. The trees are chiefly oaks and pines. There is also a pine forest on the

northern slope of the Saféd Koh range, which bounds the valley of the Kabul river on the south, it being lofty, and snow-clad almost throughout the year. The pines are *Pinus excelsa* and *Gerardiana, Abies Smithiana,* and *Cedrus Deodara:* of these the deodar appears to be the most abundant. In the temperate zone *Juniperus excelsa* is of occasional occurrence. The oak of these forests is *Quercus Ilex,* a species which extends from the south of Europe as far as Kunawar. With the oak, species of *Æsculus, Olea, Myrtus,* and *Amygdalus* occur.

In the tropical zone, which skirts the whole region, the plants are the same as those of Sind and the Panjab, which again are identical with those of tropical Arabia and of south Persia. A few scattered pistacias, with *Celtis* and *Dodonæa,* are almost the only trees; though in some valleys there are small woods of *Populus Euphratica.* The date is cultivated in Beluchistan and Southern Afghanistan up to 4500 feet, and a dwarf palm (*Chamærops Ritchieana* of Griffith, perhaps identical with the *Chamærops humilis* of Europe) occurs abundantly in many places, but with a somewhat local distribution.

Above 4000 feet, or a little higher in Beluchistan, the tropical gives place to the true oriental flora. Aromatic shrubs, chiefly *Artemisiæ* and *Labiatæ,* cover the plains, and prickly *Statice* and *Astragali* abound on the dry hills. *Cruciferæ, Umbelliferæ, Boragineæ, Cynaraceæ,* and *Cichoraceæ* are extremely abundant, far more so than in India; with *Rosa, Lycium, Berberis,* and other Syrian shrubs. In early spring there is here, as in the Mediterranean region, an extremely luxuriant vegetation, and the genera, if not the species, are the same. *Hyacinthus, Lilium, Tulipa, Fritillaria, Narcissus, Colchicum, Ixiolirion, Anemone,* and *Delphinium* may be mentioned as instances.

In many places the soil is saline, and the *Chenopodiaceæ,* mentioned as natives of Tibet, as well as *Glaux maritima,* are abundant.

The Alpine vegetation is also a mixture of European, Siberian (and Tibetan), Oriental, and Himalayan species, with little or no peculiarity.

As instances of the Himalayan flora advancing westward beyond the Indus, we may mention the following natives of Afghanistan, none of which have hitherto been detected in Persia :—

Berberis *Asiatica.*	Loniceræ, several.
Clematis *grata.*	Impatiens, sp.
Thalictrum *pedunculatum.*	Æsculus.
Corydalis *Moorcroftiana.*	Sarcococca *pruniformis.*
Edgeworthia.	Cedrus *Deodara.*
Dalbergia *Sissoo* (cult.?)	Pinus *longifolia.*
Mazus *rugosus ?*	„ *Gerardiana.*
Adhatoda *Vasica.*	„ *excelsa.*
Myrsine, sp.	Abies *Smithiana.*

The following have not, so far as we are aware, been found east of the Indus, nor in any part of British India :—

Delphinium *camptocarpum.*	Hypecoum *procumbens.*
Leontice *Leontopodium.*	Rosa *rubiginosa.*
Bongardia *Rauwolfii.*	Amygdalus *furcatus ?*
Glaucium *elegans.*	Ephedra *ciliata.*
„ *corniculatum.*	Chamærops *Ritchieana.*
Rœmeria *hybrida.*	Ægilops, several species ?

Our knowledge of the botany of this province is principally due to the labours of Griffith and Stocks. Mr. Griffith accompanied the army which marched in 1838–39 from Sind, through Quetta and Candahar to Ghazni and Kabul. From Kabul he crossed the chain of the Hindu Kúsh to Bamian and Singhan, and spent some time in the Kuner valley. His collections, though formed under circumstances of great difficulty, are very good, amounting probably to about 1000 species. Dr. Stocks twice visited Beluchistan and the southern parts of Afghanistan, penetrating as far as Quetta at considerable personal hazard. Some other collections were made while the country was occupied by the British army, but we

have not had access to any of them. Mr. Ritchie, a Bombay officer, we believe formed a good herbarium in the mountains south of Jellalabad (the Saféd Koh), which Griffith appears to have seen, but none of the specimens have found their way into our herbaria.

EXPLANATION OF THE MAPS.

MAP I.—To face page 82 of Introductory Essay.

The Map of Isothermals for January, April, July, and October, is intended to illustrate the chapters of the Introductory Essay devoted to the Meteorology of India (page 74), and of the provinces into which we have divided that country (page 115). It is compiled (by permission) from the maps of monthly Isothermals which accompany Dove's admirable work "On the Distribution of Heat over the surface of the Globe," as translated by Colonel Sabine, and published by the British Association for the Advancement of Science.

MAP II.—To be placed at the end of the Introductory Essay.

The boundaries and names employed in the Map of India divided into Provinces, have been partially explained at page 88; it remains to add a few words on our representations of its mountain and river systems.

As regards rivers, we find these to be represented in most maps as being equally numerous, and of as great volume, in some of the most arid, as they are in the most humid provinces. This arises from the fact that the larger maps are in many cases made up from local surveys, and their component parts have hence no relative value. In an arid country like Rajwara, every streamlet carrying water for a few days in the

year is of importance, and therefore mapped; whereas in Bengal, many infinitely larger perennial rivers are of no importance, and are omitted: the result is, that the two countries being brought together on a general map, appear equally well watered. We have therefore omitted in certain provinces many of the small rivers which are conspicuous in ordinary maps.

The relations of the rivers to the mountain-chains appear to us to be more or less inaccurate on our best maps of India: thus we find all the rivers on the eastern side of the peninsula of Hindostan usually represented as cutting through a coast range of hills called the Eastern Ghats; the rivers of eastern Afghanistan and Beluchistan in like manner seem to cut through a similar range parallel to the Indus; and, most extraordinary of all, the larger Himalayan rivers are made to cut through a lofty crest of that range.

The source of these errors may, we think, be traced to the neglect of a very simple law of perspective; in consequence of which, masses of mountains, of whatever configuration, resolve themselves into ranges perpendicular to the line of sight: thus, the so-called Eastern Ghats are the terminal spurs of ranges that branch off from the Peninsular chain, and which, from their number and tolerably uniform elevation and surface, form what is called the table-land of the Dekhan. The imaginary Suliman range, skirting the west bank of the Indus, is in like manner formed of the terminal spurs of ranges from a distant axis, which, with the rivers they enclose, descend at right angles to the Indus.

The Himalayan river-system is more complicated, but reducible to the same law. The great snowy peaks, as seen from the plains of India, are all thrown, by perspective, into one continuous range, and were hence originally assumed to indicate the axis of the Himalaya, and laid down as such in maps: next came the information of the natives that all the larger rivers rise behind the snowy masses; and they have consequently been represented as cutting through the

supposed axis. We now know that in whatever direction the Himalaya has been explored, its axis has been found to be beyond the snowy peaks, and indicated by the river-heads. We have therefore in all cases of doubt represented the rivers as following the courses of valleys enclosed by mountains, and assumed that the geographical axis of a chain is indicated by its watershed.

We have not hesitated to contour the table-land of the Dekhan, so as approximately to represent a system of ranges descending from the meridional axis of the Peninsula to the eastern coast, and attaining an average elevation of 1500–2000 feet. We have also given to that axis itself a more interrupted and tortuous course than is usually represented; it being an error to suppose that it forms a continuous ridge of nearly uniform height parallel to the coast. Central India we have also represented as a hilly table-land, intersected by considerable valleys; of which there is ample evidence in surveys and the accounts of travellers.

For the details of the mountain systems of East Tibet there are no authorities, but we have expressed its main features,—that of an enormously elevated mountain mass. This is proved by the statements of many intelligent Tibetans, by the Chinese geographers, by the narrative of M. Huc, and by the fact of so many of the large rivers of Asia flowing from it in several directions. To omit a feature which rivals the Himalaya in dimensions, and which exercises a paramount influence over the meteorology of Eastern Asia, would deprive our map of much of the use we hope it may be of, in illustrating the relations between the vegetation and climate of India.

It remains to add, that the system of spelling (which is the classical one) adopted both in the maps and the pages of our work, is rendered imperative from the fact that we hope our work may be useful to foreigners as well as to our own countrymen.

INDEX TO THE INTRODUCTORY ESSAY.

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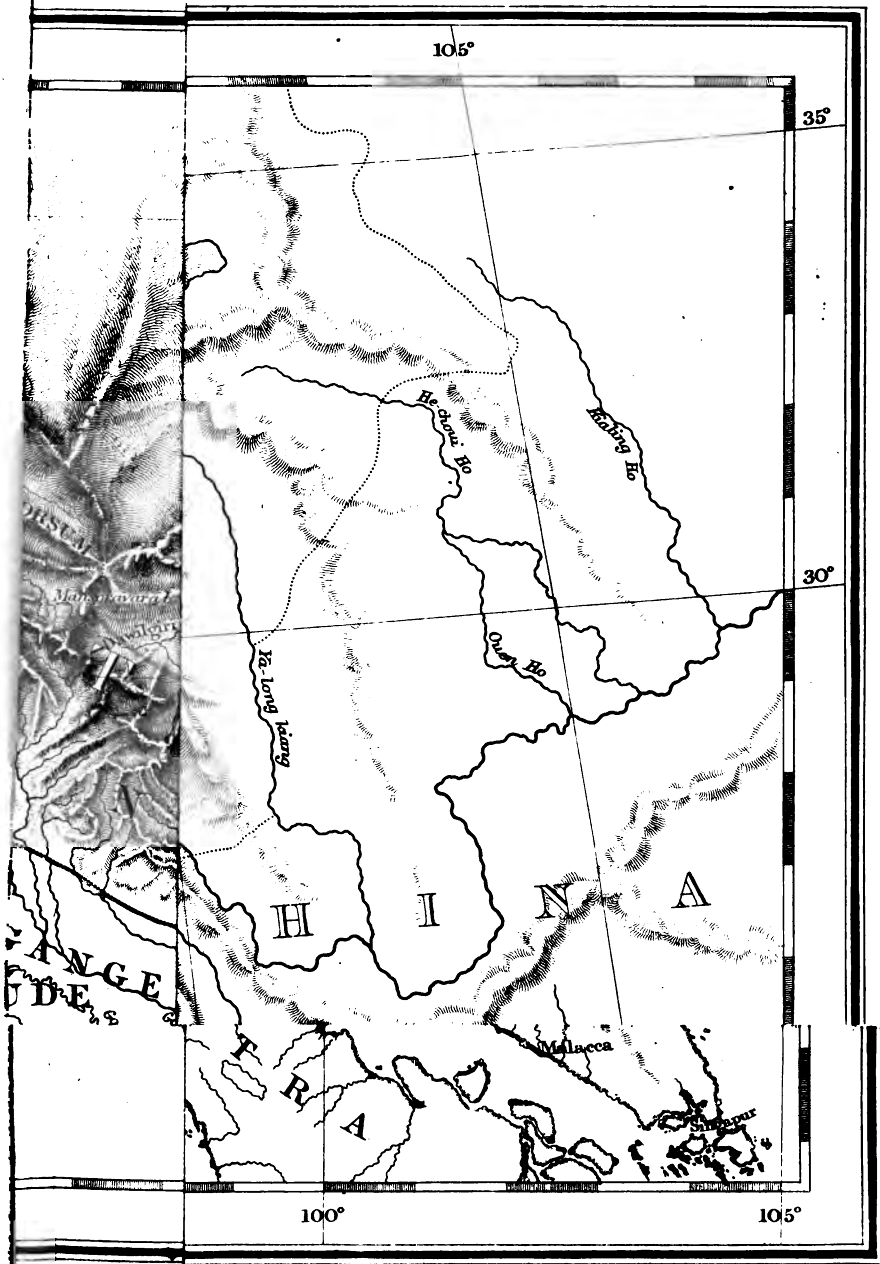

Engraved by J.& C.Walker.